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ABSTRACT

The study developed a comprehensive and detailed picture of two-year college physics instruction by conducting a survey of 1,417 faculty members who teach classes in the field. There was little difference between full- and part-time faculty in their demographic characteristics. More surprisingly, there was also little difference in academic background. In both groups, a little over one-third held a Ph.D., with almost all the rest holding a master's degree. And, in both groups, roughly two-thirds had earned a graduate degree in physics. During the 1996-97 academic year, some 120,000 students took physics at two-year colleges. Thirty-one percent were women and 15% who were members of minority groups that are traditionally underrepresented in science. Most two-year college physics students were enrolled in the same type of introductory physics course that is taught in four-year schools and universities. Few faculty indicated that they had developed ties to or received regular input from potential employers of two-year college graduates. The major problems cited by full-time faculty included students' weak math backgrounds, insufficient funds for equipment and supplies, and inadequate space for labs/facilities outmoded. The study found extremely high levels of career and job stability. There was a major discrepancy between full- and part-time faculty salaries. The report includes survey instruments, methodology, and previous studies in appendices. (Contains 15 references.) (VWC)

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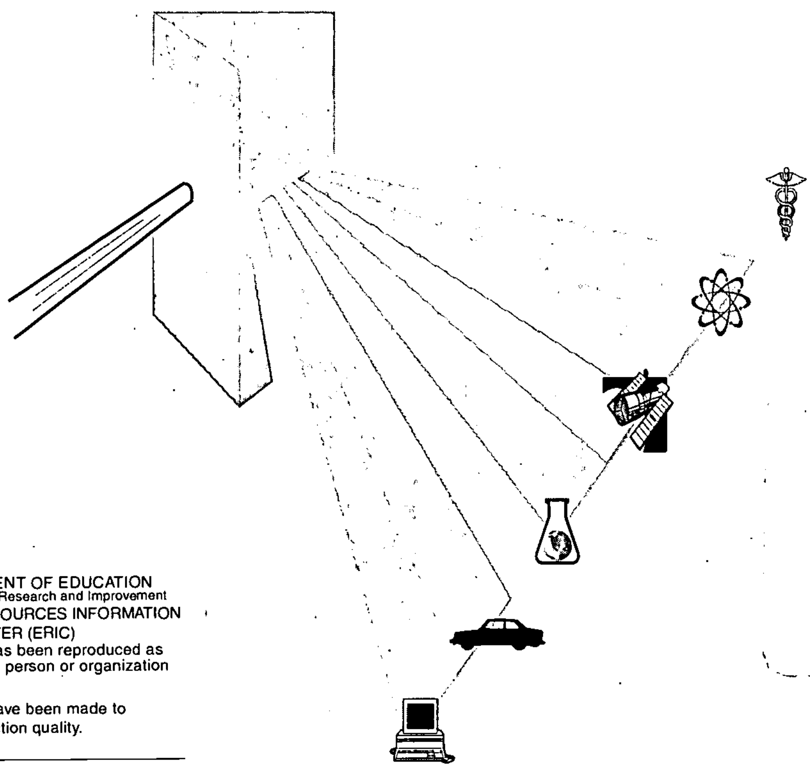
Physics in the Two-Year Colleges



By Michael Neuschatz, Geneva Blake, Julie Friesner, and Mark McFarling

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Physics in the Two-Year Colleges

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The findings in this report are the fruit of a collaborative effort of many individuals and organizations. We would like to especially thank the physics faculty participants, whose generosity with their time and willingness to express their experiences and feelings made this study possible.

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HIGHLIGHTS

- Contacting over 1,785 two-year college campuses across the United States, we found that 1,056, or 59%, offered classes in physics during the 1995-96 academic year (**page 52**).

- In the Spring of 1996, these departments contained 2,692 faculty teaching physics classes (**p. 52**). Department heads supplied the names of 2,542 professors, with 1,710 (66%) in full-time positions and 832 (34%) holding part-time appointments (**p. 20**).

- All 2,542 physics faculty were sent a detailed 12-page questionnaire, with 1,194 responding, along with another 223 who responded to a shorter version, for a total response rate of 56% (**p. 52**). Faculty were overwhelmingly male (89%), with a median age of 49. Eighty-nine percent were white, 6% were U.S. minorities, and 5% were non-U.S. citizens (**p. 21**).

- There was little difference between full- and part-time faculty in these demographic characteristics. More surprisingly, there was also little difference in academic background. In both groups, a little over one-third held a PhD, with almost all the rest holding a master's degree. And, in both groups, roughly two-thirds had earned a graduate degree in physics (**p. 21**).

- During the 1996-97 academic year, some 120,000 students took physics at a two-year college. This represented only 2% of all students enrolled in two-year schools at that time. However, given the large number of part-time and non-degree students attending classes at two-year schools, a more useful comparison would be that it included about a quarter of the entering class of full-time students (**p. 5**). It also encompassed approximately one-fourth of all students taking introductory physics at the college level during that academic year (**p. 45**).

- Included in the physics total were 31% women and 15% who were members of minority groups that are traditionally underrepresented in science, including African-Americans, Hispanic-Americans, Native-Americans, and those classifying themselves as "other." The level of underrepresentation in physics becomes evident when we compare these figures to the overall representation among two-year college students of 58% for women and 23% for minorities in the same year. Nevertheless, the underrepresentation of women and minorities at the two-year level is significantly lower than at four-year institutions **(p. 13)**.

- Most two-year college physics students were enrolled in the same type of introductory physics course that is taught in four-year schools and universities. Some 33% were enrolled in the algebra and trigonometry-based course, while 28% were taking the calculus-based or other advanced version. Only about 10% seemed to be taking courses that were specially designed for the academic backgrounds and career objectives of two-year college students **(p. 10)**.

- In line with this latter finding, few faculty indicated that they had developed ties to or received regular input from potential employers of two-year college graduates. For example, only 8% reported that they received guidance from industry-based curriculum advisory group, and fewer than one-tenth taught any courses that had been structured to incorporate the needs of local employers **(p. 17)**.

- The major problems cited by full-time faculty included students' weak math backgrounds (53%), insufficient funds for equipment and supplies (47%), and inadequate space for labs/facilities outmoded (34%) **(p. 34)**. Nevertheless, the survey registered a strong sense of job satisfaction among almost all segments of the two-year physics teaching community, with 69% saying that they would still choose two-year college teaching if they had it to do over again, and 77% saying they preferred teaching physics to other subjects **(p. 32)**.

- Along similar lines, we found extremely high levels of career and job stability. The vast majority of teachers were still at the school where they started teaching, and a high proportion indicated that they planned to remain with two-year college teaching until they retired. Thus, full-time faculty had taught for a median of 15 years and had been at their current college for 13 years, with 93% expecting to remain until retirement. Even part-timers had spent a large portion of their teaching career (with a median duration of 5 years) at their current school (median 4 years) (**p. 34**).

- There was a major discrepancy between full-time and part-time faculty in salaries. Full-timers were paid a median of $42,000 for a nine-month academic year (**p. 25**), with many also choosing to work in the summer (**p. 28**). Part-timers were typically paid per course or credit hour, with the median earnings of $2,000 and $500, respectively (**p. 38**). Part-timers rarely received the same or even proportionally equivalent levels of support as full-timers, either in office space, funding for supplies and instructional resources, or support for professional development (**p. 25**). Finally, many part-timers felt that they were undervalued in their departments, and a surprising fraction of the full-timers agreed with their assessment (**p. 42**).

- In many respects, part-timers seemed to divide into two distinct groups of roughly the same size. The first, labeled "moonlighters" in the report, had a full-time career in another occupation, and supplemented it by teaching two-year college physics. These part-timers resembled full-time two-year college faculty in a number of ways, including a fairly strong sense of career satisfaction, relatively high levels of professional activity, and a lower representation of women. The other group, whom we termed "bona-fide part-timers," had either no work other than their part-time two-year college position, or had only another part-time job. It was among these teachers that we found strong signs of dissatisfaction and "career distress." Thus, despite the fact that this group included many more PhDs (48% vs. 33%) and especially PhDs in physics (34% vs. 23%) than both moonlighters and full-timers, its members reported consistently lower levels of professional activity and greater dissatisfaction, with over half feeling undervalued by their department and over two-thirds describing themselves as underemployed (**p. 38**).

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I. INTRODUCTION

After years of relatively little attention, the American political establishment seems to have recently rediscovered two-year colleges, and especially their science and technology education programs. Judging from recent speeches from the President (AACC, 1995:1) on down, a great deal is now expected from two-year schools in terms of their potential for reinforcing economic competitiveness, boosting sections of the population historically excluded from the "American dream," retraining workers left behind by technological advances, and achieving similar goals from almost everyone's national agenda.

Yet, for all this recent notice, two-year schools still occupy a subordinate place in the American education system. While some two-year institutions have been around for years, it is only since the 1960s that the notion of an intermediate level between secondary education and baccalaureate studies has really become widely established. And it is only in very recent years, as these schools grew, spreading as junior colleges (now community colleges) or technical colleges, that a new sense of purpose has truly begun to take root, moving beyond the image of simply an alternative venue for the first two years of traditional college studies.

This evolutionary process for two-year schools is still far from complete. There remain many competing conceptions of the appropriate mission, something that is not surprising given the multi-faceted role and varied constituencies that two-year colleges have come to serve in their evolutionary process. However, it is now increasingly-widely acknowledged by educators, social scientists, and government administrators that two-year colleges form a crucial and heretofore under-recognized part of our educational system. Their accessibility, local orientation, flexibility, and tradition of post-secondary studies on a "human scale" are now touted in many forums as unique and irreplaceable assets.

It is precisely their continuing adaptation to different agendas that precludes two-year schools from finding a clear, universally accepted niche in our educational system. In varying degrees, they function as:

- a capstone to universal primary and secondary education;
- a bridge between high school and further post-secondary study;
- an alternate route back into the educational pipeline for those who left for a wide range of reasons;
- a vehicle for delivering vocational training and career-advancement certification to on-the-job workers as well as students; and
- a resource for community education, providing skill upgrading and "recreational studies" for adults at all life stages who may have no formal academic goals in mind.

If two-year colleges can be fairly described as the stepchild of the American education system, it can also be argued that in no discipline is this truer than physics. Many university-based physicists regard two-year college instruction as lying outside the "mainstream" of physics education. Perhaps more than most disciplines, physics has been dominated by the agendas and views of those involved in graduate studies, especially at the doctoral level. For example, the proportion of those who receive bachelor's degrees in physics who continue on to graduate study in the same field is consistently around one-third, a considerable fraction. And the number of physics bachelor's degree recipients who go on to earn a PhD in any field is proportionately five times as high as the corresponding number for all bachelor's degree recipients. As a result, while physics may be arguably portrayed as one of the more carefully studied — and self-studied — of disciplines, investigations into physics education at the two-year level have been few and far-between.

But the attitudes underlying this neglect are also starting to change. There is growing recognition that physics has an important part to play in technical as well as academic studies, that even where the desired outcome involves practical skills, an appreciation of underlying scientific principles is critical in both speeding the acquisition of the material and enabling its application to a wide variety of settings. At the same time, a number of renowned research physicists have turned to study the way in which introductory-level students learn physics concepts, and this attention has made introductory-level instruction a more "respectable" concern. Finally, at a time when education authorities and government funding agencies have been stressing the theme of "science for all," many physics departments and laboratories have been spurred to reach out and strengthen their interactions with physics educators from all parts of our academic complex.

It is in this context that the present study emerged. For many decades, the Education and Employment Statistics Division of the American Institute of Physics (AIP) has regularly conducted surveys designed to document the outcomes of the post-secondary physics education, both in terms of degree production at the undergraduate and graduate level, and in terms of student experiences and plans. In the mid-1980s, the Institute expanded its research to include the experiences of physics teachers and the structure of the physics curriculum at the high school level. Around the same time, studies were also added that probed the condition of the academic workforce at four-year colleges and universities.

These additions still left one major gap in the overall picture of physics education in the United States, and in the early 1990s, with the encouragement of its member societies and especially the American Association of Physics Teachers (AAPT) and the American Physical Society (APS),

the AIP undertook to seek funding for a comprehensive study of physics education at the two-year college level. A proposal was submitted to, and ultimately funded by, the National Science Foundation's Division of Undergraduate Education, as part of its Advanced Technological Education program.

There have been a number of studies that looked broadly at science and technology education at two-year colleges. (See, for example, the discussion of three recent studies — NSF (1989), NSF (1991), and NSF (1992) — in **Appendix A**.) Unfortunately, physics, a numerically small discipline even at the four-year college and university level, tends to be so small a part of the two-year college scene that it gets lost in the shuffle, rarely meriting any special attention or mention. For this reason, as well as for the reasons noted above, only a few prior efforts focused specifically on the extent and condition of physics education at the two-year college level. **Appendix A** contains a review of the major examples of such studies.

II. METHODOLOGY OVERVIEW

Our strategy for developing a comprehensive and detailed picture of two-year college physics instruction was to conduct a survey of faculty members who teach classes in the field. This was done on the premise that they would be the most appropriate and reliable source of information on both their own characteristics and on the courses they taught.

Unfortunately, a search of existing resources turned up no available listing of physics faculty that even came close to completeness. As a result, we found it necessary to start from scratch. The first step was to develop an exhaustive list of two-year college campuses from U.S. government databases and from rosters maintained by the American Association of Community Colleges (AACC). We then contacted the administrative offices on each campus to determine whether physics was offered there, and if so, in which department or division. We then surveyed each of these programs, requesting the name of every faculty member teaching physics that year. Remarkably, repeated mail and phone follow-up enabled us to achieve a higher than 99% participation rate at each of these stages.

These queries yielded a list of 1,056 campuses offering physics, including 33 where physics was offered in two different departments, out of a total of 1,785 campuses. We were also given the names of 2,542 faculty teaching physics in the spring of 1996. (The faculty questionnaire also yielded the names of an additional 150 faculty, mostly part-timers, who taught physics in the Spring but were identified too late to be included in the survey.) These teachers were then mailed detailed questionnaires covering their backgrounds, teaching experience, current institutional environment, instructional approaches, and future plans. We received a response from 56%, including 9% who completed an abbreviated version of the questionnaire. Greater detail on the methodology used in this study can be found in **Appendix B**.

III. TWO-YEAR COLLEGE PHYSICS PROGRAMS IN THE U.S.

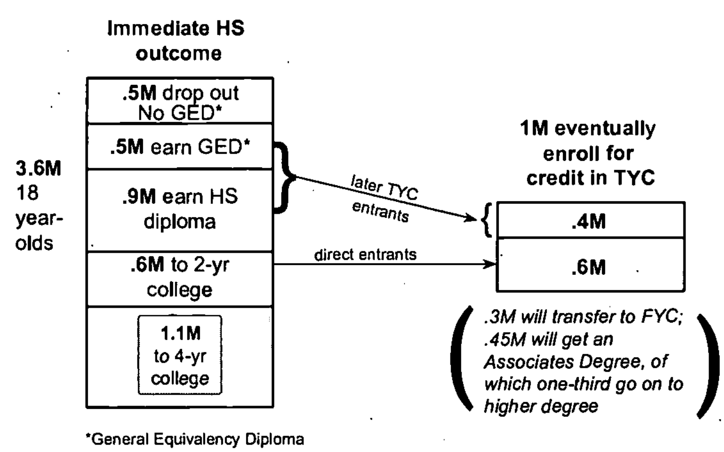
A. WHO ATTENDS TWO-YEAR COLLEGES?

As was mentioned at the outset, two-year colleges play a multi-faceted role in the American system of higher education, providing different educational experiences for distinct groups within the population. In order to get the most out of the figures for two-year college physics presented below, it is helpful to have a rough picture of the overall institutional context. **Figure 1** combines data from a number of sources to illustrate the flow of college-age students into two-year colleges in general. These numbers do not include the substantial number of people who take occasional classes that are not part of a formal course of study, nor do they include those who enroll in two-year programs after 5 or more years outside academe, or those who return for specific objectives after earning a college degree elsewhere.

As the graphic shows, roughly three-fourths of each age cohort graduate from high school, with approximately half of the dropouts ultimately earning an equivalency diploma (GED) in subsequent years. Of the high school graduates, almost two-thirds go directly into college, with 23% of the total going into two-year schools. Among graduates who do not go directly on to college, around half will matriculate into two- or four-year degree programs within the course of a few years, along with a somewhat smaller proportion of dropouts who go on to earn their GEDs. All told, just under one million freshmen enter two-year colleges each year, along with one-and-a-quarter million freshmen entering four-year schools.

Figure 1: The two-year college pipeline in the late 1990s

(figures in millions of students)



*General Equivalency Diploma

Sources: US Department of Education - NCES, *Digest of Education Statistics*,1996:108,110 & 115 1997:191 & 424; American Council on Education, *The American Freshman*, 1996:13; 1996 AIP Two-Year College Physics Study

However, there are a number of significant differences between the two groups. For one thing, all but 3% of the entering four-year college freshmen are full-time students, while around half of the two-year entrants are part-time, with many holding full or part-time jobs as well as attending school. A related difference is that two-year college freshmen tend on average to be older than their four-year counterparts, with some having taken longer to graduate high school or earn an equivalency diploma, and others taking a few years off to work between high school and college. The difference in academic climate is further compounded by the fact that two-year schools tend to have a higher proportion of non-matriculating students, who are not enrolled in an accredited degree program, but are taking individual courses to improve a specific skill, earn a non-degree credential, or follow a personal interest.

As mentioned earlier, one important function of two-year schools is to serve as a pathway to baccalaureate studies. In the long run, somewhere around 30% of two-year college freshmen enrolling in a formal Associate of Arts (AA) Degree program transfer to four year schools, perhaps half after earning an Associate's degree. Another 30% graduate with an AA and enter the work world, while some 40% do not complete a two-year degree program.

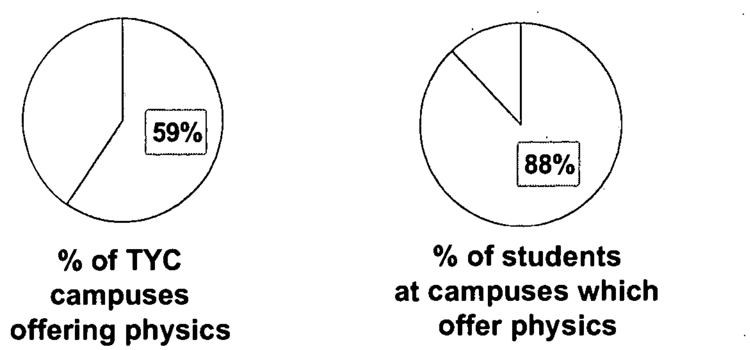
Overall, there are close to six million students currently enrolled for degree credit in two-year schools, although only about two million of them attend full-time. The larger figure count may also be somewhat misleading because some schools include students enrolled in certificate programs lasting less than two years. Nevertheless, these figures serve to provide the general outlines of the student body that has the potential to be reached by physics programs on two-year college campuses in this country.

B. WHERE IS PHYSICS TAUGHT?

It may appear shocking that, as reported earlier, fully 40% of two-year college campuses in the U.S. do not offer any physics courses, given that it is missing from the curriculum at only 15% of the nation's high schools and a similarly low proportion of the comprehensive four-year colleges in any given year. However, further analysis, illustrated in **Figure 2**, shows that there are mitigating factors which make this finding for two-year schools somewhat less alarming. Foremost among these is that the campuses where physics is not offered are more often small, stand-alone schools or lesser sub-campuses of larger systems. As a result, their combined student enrollment represents a much smaller percentage (only 12%) of all two-year college enrollment nationwide.

Across the country, there are no major differences in the proportion of schools offering physics by geographic region, with

Figure 2: Physics availability at two-year colleges

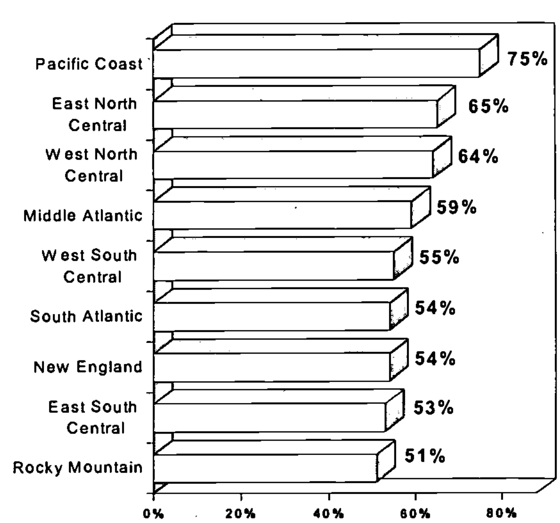


Source: 1996 AIP Two-Year College Physics Study

one notable exception — two-year colleges in the Pacific Coast region are somewhat more likely to offer physics courses than elsewhere in the U.S. (see **Figure 3**). The explanation is likely to stem from the long-standing policy in California, the dominant state in the region, which encourages many students to take their first two post-secondary years at a two-year school and then transfer. This tends to raise student enrollments, both overall and per campus (California's two-year college campuses average twice as many students as the national norm), which will be seen below to have a major effect on physics offerings regardless of other factors. The same policy also attracts more transfer-oriented students to two-year colleges. As with their counterparts already at four-year schools, such students are more prone to take physics than students who do not plan to continue their schooling beyond their second year of college.

Type of institutional control (public or private) has a far greater impact on whether physics is taught than geographical location. Eighty percent of the two-year colleges that met the criteria for inclusion in the study are public institutions, and two-thirds of their campuses offer physics classes. In contrast, even among the

Figure 3: Percent of two-year colleges offering physics, by region



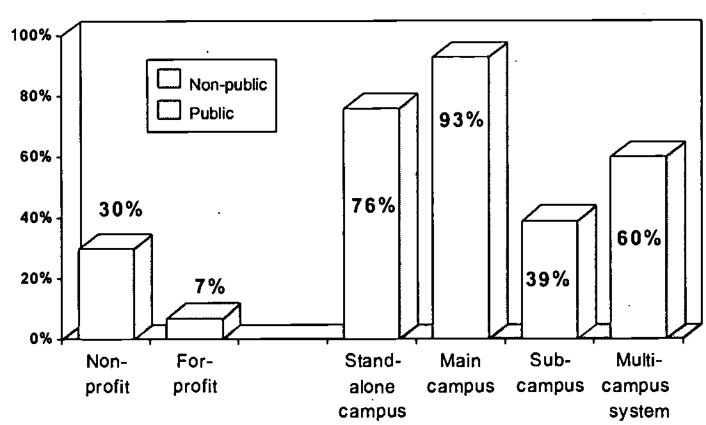
Source: 1996 AIP Two-Year College Physics Study

fraction of non-public two-year college campuses (generally the largest and most academically oriented) that made it into the study, physics is a rarity, with only 30% of the private not-for-profit schools and less than a tenth of the for-profit ones offering it.

But even within the public sector, physics offerings are far from homogenous (see **Figure 4**). Just over half of the public two-year colleges are independent stand-alone institutions, and 76% offer courses in physics. The balance of public two-year colleges is organized into local or regional systems, some with designated central campuses and sub-campuses and some as constellations of more-or-less equal affiliated campuses. Where a central campus/sub-campus configuration exists (the most common arrangement), almost all of the central campuses offer physics, whereas only about three out of eight of the sub-campuses do. Where no central campus has been designated, about 60% of the affiliated schools offer physics.

While institutional arrangements have a strong impact in their own right on the availability of physics, the extent of physics offerings is, as indicated earlier, even more strongly impacted simply by the size of a given campus. Programs in disciplines, such as physics, with historically low enrollments at the two-year college level, are especially sensitive to the constraints of small school size. Both private schools and sub-campuses of public systems tend to have much smaller overall enrollments, by almost an order of magnitude, than public sector central campuses or stand-alone units — and are hence less likely to have the enrollments necessary to support at least one physics class. Of course, other factors, such as the demographics of the student body and the educational mission and orientation of the school, come into play as well.

Figure 4: Percent of two-year colleges offering physics, by campus type



Source: 1996 AIP Two-Year College Physics Study

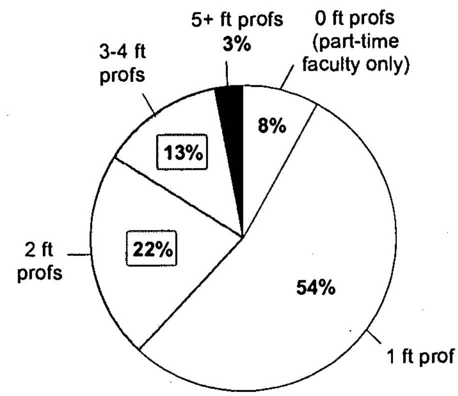
C. CHARACTERISTICS OF PHYSICS PROGRAMS

As noted earlier, there were 1,056 campuses across the United States where physics was offered in the Spring 1996 term, with 33 of these campuses offering physics courses in two different departments. These departments ranged in size from 1 to 19 faculty teaching physics, contributing to a total of 2,692 full- and part-time two-year college physics teachers that term.

These faculty are distributed in a far from even fashion (see **Figure 5**). The fact that over half of all campuses have only one full-time faculty member teaching physics is at the root of the oft-cited problem of isolation of these faculty. Even when we include part-time faculty, almost half of all campuses have only one physics teacher.

Overall, 34% of the faculty listed by departments held part-time appointments. (This can be compared to the situation in mathematics, where 65% of the two-year college faculty were part-timers, frequently hired to teach remedial courses, as reported in Loftsgaarden *et al.,*1997:96.) Our data indicate that part-time physics faculty tend to be concentrated in larger departments, with their proportion rising steadily as program size increases. As a result, 68% of part-timers are at schools with more than three physics faculty in total, where they constitute nearly one-half of all the physics faculty.

Figure 5: Number of full-time physics faculty in department



Source: 1996 AIP Two-Year College Physics Study

But while such differences in departmental setting play a role, the contrast between the utilization of part-time and full-time physics faculty remained relatively consistent across all types of departments. For example, part-timers were typically hired specifically to teach physics, generally being assigned from one to three physics classes at a time. In contrast, a substantial proportion of full-time faculty were assigned to teach other subjects as well as physics. This pattern prevailed even in small departments, where low enrollments and limited course offerings in physics generally resulted in all faculty being called upon more often to teach other fields.

D. THE PHYSICS CURRICULUM

Paralleling the wide range of faculty per department, departments also varied widely in the extent of their course offerings, with the number of separate physics sections

ranging from 1 to 49. But just as most campuses only had one or two professors teaching physics, so almost half the departments had three or fewer physics sections in a given term. The small number of sections in these programs necessarily also limited the variety of physics courses that could be offered.

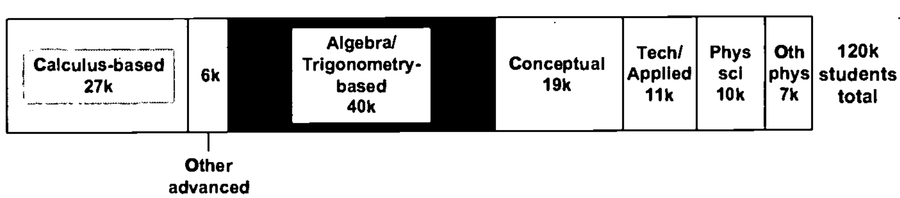
We asked teachers to divide their courses into seven different categories, based on the level of mathematics involved and whether the presentation stressed basic physics principles or focused on applications. **Figure 6** illustrates the distribution of physics enrollments into these course types in two-year institutions nationwide and provides a list of the titles of the courses that were most commonly offered.

One especially noteworthy aspect of the distribution is that the traditional algebra/trigonometry-based and calculus-based courses continue to predominate in the two-year college curriculum. These are essentially the same introductory courses that are offered to science and related-field majors at four-year colleges and universities, generally using the same books and covering the same topics. One reason for this dominance may be that physics, with its reputation as a difficult and demanding subject, attracts mainly (although certainly not exclusively) transfer-oriented students. Such students generally need courses equivalent to those taught at four-year schools in order to earn transfer credit.

The flip side of the distribution is that physics courses specifically designed for two-year college students, especially those pursuing an associate's degree or a certificate in a technical field, seem to play

Figure 6: Two-year college physics curriculum

Types of courses offered and enrollments in each type (in thousands)



The most common names of physics courses listed

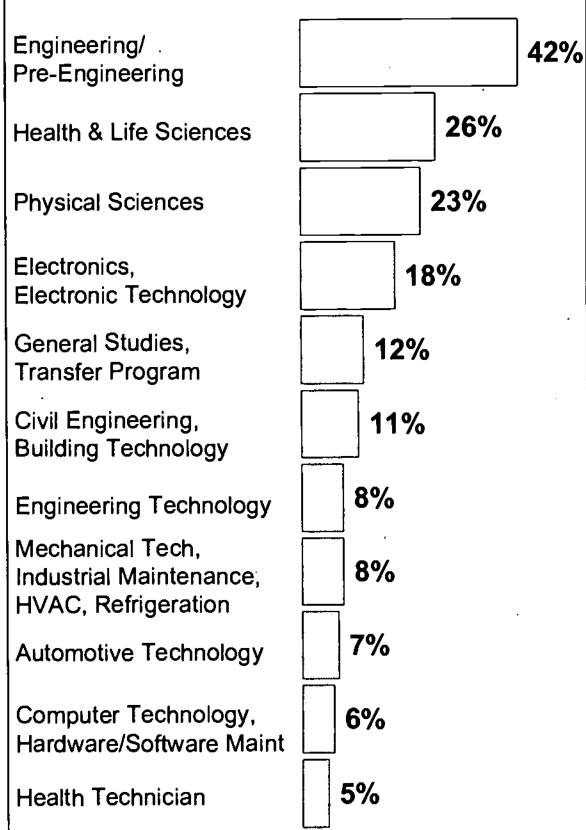
General physics	Applied physics
University physics	Mechanics
College physics	Electricity & magnetism
Engineering physics	Heat, light, and sound
Technical physics	Optics

Source: 1996 AIP Two-Year College Physics Study

a relatively minor part in the curriculum. Less than one-tenth of the courses reported by the teachers fell under the heading of "Technical or Applied Physics," and even when we folded in a separate category listed as "Technology courses with half or more of the content in physics," the total only added up to just one-tenth.

One key reason for the relative weight of traditional academic introductory courses in the two-year college physics curriculum emerges when we look at the role physics plays in the larger curriculum. Given that virtually no students at the community college level specialize in physics itself, it is the needs of other programs that dictate the type of physics that is most commonly offered. As can be seen in **Figure 7**, the programs most commonly cited as requiring their students to take a physics course are generally also programs which are aimed at students planning to transfer to four-year schools. Only towards the bottom of the list do we encounter programs associated primarily with vocationally-oriented instruction specific to two-year colleges.

Figure 7: Percent of schools with various programs requiring physics as a service course



Source: 1996 AIP Two-Year College Physics Study

Table 1 shows the most widely used textbooks in each major type of course. Because there were few second-year courses offered and these were almost exclusively calculus-based, this category was combined with calculus-based introductory physics. Physical science was omitted because of the low incidence of this course being offered and because no single textbook was mentioned by more than 6% of the teachers. As is evident from the table, only in Conceptual Physics does one text come close to being dominant. In the case of Technical and Applied courses, perhaps in part because of the variety of applications, no single text comes even close to dominance.

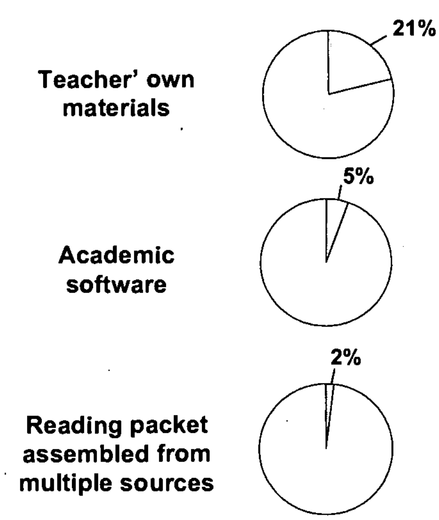
In addition to, and in some cases in place of, published textbooks, many faculty

Table 1: Most widely used two-year college physics textbooks	% of faculty using this textbook
Calculus Based Physics	
1. *Physics for Scientists & Engineers* (Serway)	36
2. *Fundamentals of Physics* (Halliday et al.)	23
3. *University Physics* (Young)	13
Algebra/Trigonometry Based Physics	
1. *College Physics* (Serway & Faughn)	25
2. *Physics* (Cutnell & Johnson)	12
4. *College Physics* (Wilson)	11
3. *Physics: Principles with Applications* (Giancoli)	11
Conceptual Physics	
1. *Conceptual Physics* (Hewitt)	45
2. *Physics: a World View* (Kirkpatrick & Wheeler)	9
Technical/Applied Physics	
1. *Technical College Physics* (Wilson)	16
2. *Applied Physics* (Tippens)	11

Source: 1996 AIP Two-Year College Physics Study

had their students use course materials that they wrote or assembled themselves (see **Figure 8**). In every category of course, approximately one-fifth of the teachers reported employment of such materials. This may be especially common to the laboratory component that is a key part of most introductory physics courses, where there is ample opportunity for supplementing the formal courseware. On the other hand, as **Figure 8** shows, it is clear that academic software has not yet had a significant impact on two-year college physics instruction.

Figure 8: Percent of faculty using materials other than textbooks in physics courses

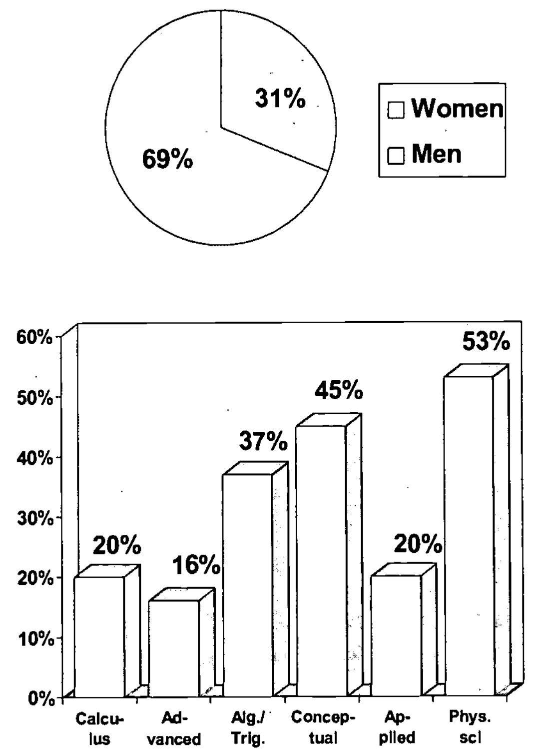


Source: 1996 AIP Two-Year College Physics Study

E. THE STUDENTS

Physics is known as one of the science disciplines that has historically had very low participation of women and members of minority group members, with the exception of Asian-Americans. It has often been suggested that community colleges are the exception to this pattern. However, while physics programs at the two-year level may fairly claim a slightly better record than their four-year college and university counterparts, the following discussion makes clear that there is still a major problem with uneven representation.

Figure 9: Percent of TYC physics students who are women, overall and by course



Source: 1996 AIP Two-Year College Physics Study

Figure 9 shows the participation of women in two-year college physics courses, both overall and by type of course. The overall figure of 31% is far short of the 58% of all two-year college students who are female, and falls roughly midway between the figure for high school (43% in 1993) and the figure for introductory courses at four-year schools (estimated at around 25% in 1993). Moreover, in terms of representation by type of course, the identical pattern emerges here as appears in high school physics (and probably characterizes four-year college physics programs as well). The highest proportion of women are found in the courses that require the least in terms of math background, specifically conceptual physics (usually taken by students not going into a science- or science-related field) and physical science, often favored by elementary education majors. An intermediate level of women are found in the algebra-based courses, traditionally taken by students heading into the life and health sciences, including pre-nursing. Finally, far lower representation of women appears in the calculus-based and other advanced courses, favored by students heading into engineering and the physical sciences.

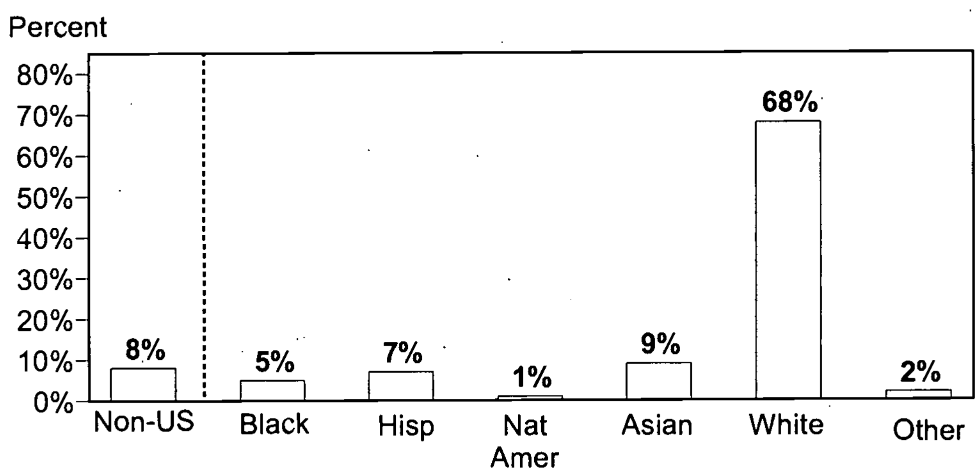
The underrepresentation of minorities in physics is also a significant issue at two-year schools, as it is at other academic levels. As **Figure 10** shows, more than two-thirds of physics students at the two-

year level are white, and when we exclude the small number of non-U.S. citizens, that number rises to almost three-quarters. Due to the small numbers of minority students and the differences that prevail between the various groups, it was not possible to make the kind of comparison by type of course that was presented for women.

Figure 11 compares the overall participation of minorities in physics at the two-year level with their participation at other academic levels. As mentioned earlier, Asian-Americans, traditionally well represented in physics, are grouped with white students, while African-Americans, Hispanic-Americans, Native-Americans, and students classifying themselves as "other" are grouped together as historically underrepresented in physics. As the figure shows, while underrepresented minorities are better represented in two-year college physics than they are at other levels, their presence in physics classes remains significantly below their presence in the student body as a whole.

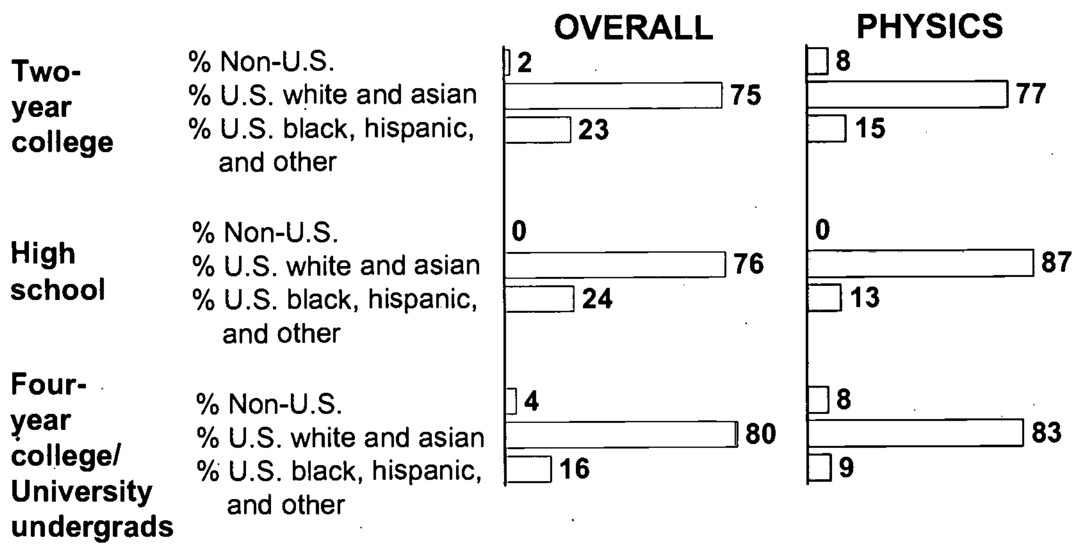
Two of the distinguishing characteristics of two-year colleges, and among the features that make them especially attractive to many students, are the small size of the classes and the devotion to teaching as the primary task. Many incoming freshmen at four-year schools and especially universities find their first introduction to college physics in a large lecture hall with hundreds of other classmates, while their more "intimate" lab or recitation section experience is with a graduate teaching

Figure 10: Racial make-up of two-year college physics students



Source: 1996 AIP Two-Year College Physics Study

Figure 11: Racial make-up of students at different academic levels



Sources: 1996 AIP Two-Year College Physics Study; 1992-93 AIP High School Physics Teacher Survey; AIP *Enrollments and Degree Report, 1998;* National Center for Education Statistics, *Digest of Education Statistics, 1997:214*

assistant whose attention is mostly focused on their own coursework or upcoming comprehensive exams. In two-year physics programs, the overall median physics class size is 17 (with an average of 20), and in only 5% of the cases does it reach as high as 35. For the algebra- and calculus-based introductory courses that match those at four-year schools, the figure is even lower, with a median of 15 students per class. For comparison, the average class size in two-year college mathematics programs is 26 (Loftsgaarden *et al.,* 1997:95).

Small class size may be especially helpful for students who enter college at risk for failure. Without a strong academic background, such students may often find themselves lost in the anonymous world of large lecture classes. Greater contact and interaction with faculty often help these students over the initial barriers and maximize their chances of success. However, the smaller scale can potentially benefit all students, not just those at risk. Both the questionnaire and the face-to-face interviews with students by the project evaluator yielded anecdotal hints that a number of four-year college students opt to take some of their introductory physics classes at nearby two-year schools precisely because of the smaller classes and more personalized attention they receive. Indeed, the same small class environment is often touted as one of the advantages of the most prestigious and highly selective colleges in the nation.

F. THE INSTITUTIONAL ENVIRONMENT

Unlike the situation in four-year colleges and universities, physics rarely stands alone as a separate department in two-year colleges, as evidenced in **Table 2**. According to the respondents to our departmental survey, at the least, physics tends to be embedded in a larger physical science department, including disciplines such as chemistry and earth science. Slightly more common is for all the physical sciences to be included with the life sciences in an overall natural science department. But the most common arrangement by far is for mathematics, and often engineering and computer science as well, to be combined with the sciences. Finally, at the other extreme, a substantial number of schools simply lump all of the academic disciplines together into a single division, as distinguished from the vocational and recreational programs.

As would be expected, the relative size of the physics presence in a department or division depends on the array of other disciplines included. Of course, in standalone physics departments all of the faculty teach physics. For physical science departments, the median proportion of faculty who teach at least one physics course drops to one-third. For natural science departments, the median proportion is only 13%, while for combined science/math divisions the median proportion teaching physics is only 10%. For general studies, the corresponding figure is 6%.

Table 2. Institutional locus of physics programs

Standalone physics department	4%
Part of physical sciences division	5
Part of natural sciences division	8
Part of science & math division (often including engineering and computer science)	54
Included in general or academic studies program	29

Source: 1996 AIP Two-Year College Physics Study

Another key characteristic that turns out to vary greatly by discipline is the use of part-time teachers. In general, two-year colleges use far more part-time faculty than four-year schools and universities do (NCES/NSOPF, 1997:14). But even within the two-year level, the use of part-time instructors is far more common in many other disciplines than it is in physics. One example would be the previously mentioned prominence of part-timers in two-year mathematics programs (Loftsgaarden *et al.,* 1997:96). In physics we found just the reverse, that the proportion of full-time professors was twice the level of those with part-time appointments. The difference is probably attributable to the larger role played by remedial courses in two-year college mathematics, coupled with the fact that part-time instructors are often hired specifically to teach these remedial courses.

Of all other science disciplines, astronomy is probably the field most closely allied with physics both historically and in subject matter. In the two-year college curriculum, however, astronomy seems to be less closely linked to physics. Although almost 60% of the divisions that offered physics also included at least one introductory course in astronomy, only 14% of the physics faculty also taught astronomy in the Spring 1996 term (with two-thirds of these teaching only a single course in that field). It thus appears that at the two-year level, faculty from other fields — such as earth science — were at least as likely as physicists to be assigned the astronomy courses.

In addition to information on a department's internal structure, the study gathered data on each department's interaction with related units, both on-campus, at other schools, and in the surrounding community. Not unexpectedly, we found the most widespread ties to be those with other academic institutions. Thus, in terms of arrangements to facilitate student transfer to four-year programs, two-thirds of the departments which had physics professors responding were covered by a transfer or articulation agreement with at least one four-year school, and almost as many (57%) maintained a blanket agreement with many of the schools in their state.

In terms of relationships with high schools, 56% of the two-year level physics departments were reported as having courses that were open to local high school physics students, although only 12% of the departments granted credit in their program for physics courses taken in high school. The questionnaire also included a series of items looking into the presence on each campus of "tech-prep" and similar programs centering on collaborations with local high schools in formal school-to-work transition programs for training technicians. Here, among respondents who reported being aware of whether such arrangements existed (26% — mostly part-timers — indicated that they were not sure), 40% indicated that their institution offered some kind of school-to-work program. However, in almost half of the cases, the faculty member's own department was not directly involved in the program.

Links and collaborations that went beyond the bounds of academia were even less in evidence. For example, the issue of ties between two-year colleges and local employers has received increased attention in recent years. Thus, we included several items on the questionnaire that were designed to probe the extent of these links for physics from a number of different angles. At the simplest level, faculty were asked whether their physics program received guidance from an industry-based curriculum advisory committee. Fewer than 10% answered affirmatively (again with a substantial fraction of the part-timers indicating that they had no idea). Along similar lines, professors were asked whether any of the courses they taught were organized in response to the specific

needs of local employers, and again fewer than a tenth indicated that was so. Finally, the questionnaire looked into whether arrangements existed to place students in internships or co-ops with specific employers either during or following their course of study. Once again, only a small fraction (around 13%) were able to answer yes to any kind of arrangement of this type.

Another area of concern is the coordination of support services and teaching resources among various offices and programs within each campus. This is especially important given widely heard complaints about students coming in without adequate skills to handle the demands of higher education. In our own survey, the aspect of two-year college physics teaching identified as most daunting — described as problematic by over 90% of respondents and a serious problem by half — was the weak mathematics background of their physics students.

In light of this, it was reassuring that roughly three-fourths of the respondents reported that a science resource or tutorial center was available to students on their campus. The most common arrangement was to provide tutoring by other students, although 41% reported tutoring by part-time staff and 28% indicated that full-time staff were available for that purpose. Among other services, 46% mentioned computer tutorials or labs and 38% reported the use of instructional videos or other multimedia resources.

G. DEPARTMENTAL RESOURCES AND OUTLOOK FOR GROWTH

As important as the availability of institutional supports may be, it is the level of resources provided within the department or division that has the greatest and most direct impact on faculty and students. Thus, as will be seen in more detail below, one of the major complaints of physics faculty — especially full-timers — at two-year schools is the lack of support staff to assist them with tasks that are ancillary to classroom instruction. When we asked department/division heads how many clerical or other administrative support staff were available in their units (which averaged 29 total full- and part-time faculty), more than one-fourth of the chairs reported none, and half of the rest indicated that there was only one such person in their department or division. Similarly, when asked about the number of laboratory assistants or other instructional support staff in the department or division, 30% said none were present. These responses clearly form the basis for the complaints of poor support echoed by many of the faculty.

Departmental support structures for students appear few and far between, as well. According to faculty respondents, only 4% of the campuses had a Society for Physics Students chapter. In fact, barely a third of the campuses were described as offering any type of science or engineering club. And respondents at only a fifth of the campuses indicated the availability of

programs to encourage women and minorities in science and engineering, and fewer than half of those indicated any personal involvement in such programs.

Perhaps as a result of the absence of such programs, two-year college physics programs do not appear to be in a growth mode. For example, faculty most commonly reported relative stability in student enrollments in physics in recent years, and among those indicating change, more reported declines than gains. Only one in seven reported that their department had any kind of program in place to address this stagnation and promote higher enrollments, and even where such programs existed, few saw them as especially effective. Indeed, the one place where faculty were more likely to report growth than retrenchment was in the number of part-time instructors used to teach physics. (A similar finding emerged from our earlier survey of department/division chairs, who also reported greater growth in the use of part-time than full-time faculty for their entire unit over the previous three years.)

We now turn from the physics programs to the backgrounds, current practices, and outlooks of the physics faculty who teach the courses. As might be expected, the institutional environment just described exerts a strong influence on the way physics is taught and on the type of instructor who is attracted to work in a setting that is so removed from the "physics mainstream."

IV. PROFILES OF TWO-YEAR COLLEGE PHYSICS FACULTY

In the Introduction, two-year college physics education was described as the most neglected segment of the physics teaching enterprise, a view corroborated in previous research. (See, for example, NSF, 1992.) The AIP survey found that this perspective was also widely shared among two-year college physics faculty, many of whom felt that the attitude carried over into their own professional standing. Despite the fact that many respondents felt great satisfaction with their work, fewer than one-quarter felt that they were well respected as a group by the rest of the academic physics community. This marginalization has also found reflection in the dearth of research previously done on the conditions these faculty face and the approaches they take in response (see **Appendix A**). In part, this study was designed as an attempt to bring to remedy that lack.

A preliminary look at the findings makes it apparent that broad contrasts can be drawn between the status and working conditions of two-year college physics faculty and the more familiar situation of their counterparts at four-year schools. Many of these follow directly or indirectly from the differences in the stated missions and the institutional environments at the two levels. Among these are the pattern of two-year physics faculty having larger course loads, spending a greater percentage of their time on teaching-related activities, receiving lower compensation, and having access to fewer support services and available resources.

Moreover, funding for public education in many states has been under attack in recent years from many quarters, and two-year institutions often find themselves with fewer powerful and vocal allies than competing sectors in the scramble for funds. This further widened the gap with four-year colleges and universities, with impacts on faculty course loads, use of and compensation for part-time teachers, availability of money for materials and support personnel, and the like.

Yet, the situation in physics is far from the most extreme. For example, as already noted in the preceding section, the percentage of part-timers is still far below the level found in mathematics and a number of other disciplines. Our survey of department chairs showed that 66% of the two-year college faculty who taught physics in 1996 held full-time positions, almost always permanent or tenure-track appointments. Nevertheless, this leaves a significant (and anecdotal evidence suggests growing) percentage of part-time faculty, including a significant percentage who do not have another primary job and depend on their two-year college position(s) as a primary source of income.

A. FACULTY CHARACTERISTICS

This section presents findings on faculty demographic characteristics, workloads, educational and professional experience, compensation, teaching assignments, resource allocation, and professional involvement. Some of the differences between full- and part-time faculty are also highlighted here, although detailed discussion of the special situation of part-timers is reserved for a later section. The tiny fraction of full-timers with temporary positions (less than 2%) were classified with part-timers for purposes of analysis.

Demographics

Full- and part-time faculty displayed similar demographic profiles. The mean age for both groups was virtually the same — 49 years for full-timers and 50 for part-timers. There was also little difference in gender or ethnic composition. Overall, approximately 11% of faculty were women, about double the percentage at four-year colleges and universities and half the percentage among high school teachers. Only 4% of two-year college physics faculty were members of underrepresented minority groups, comparable to the percentage among physics teachers at both the high school and four-year level. The overwhelming majority of faculty were U.S. citizens. Only 5% of full-time and 6% of the part-time faculty were non-citizens (generally from Asia or the Middle East), and virtually all of them held permanent visas.

Professional Background and Experience

Nearly all two-year college physics teachers held advanced degrees, and for the majority, those degrees were in physics (see **Figure 12**). Seventy-nine percent of full-time faculty and 76% of part-timers who taught physics held one or more physics degrees.

However, these findings mean that 22% of those teaching physics at the two-year college level have never earned any degree in physics — 21% of full-timers and nearly one-quarter of part-timers. Most of the individuals in this group had earned their highest degrees in engineering (34%), education (19%), chemistry (15%), or mathematics (13%), and for three-quarters that highest degree was a master's. (These numbers also exclude 4% of respondents — evenly divided between full-time and part-time faculty — who indicated that they were still students, with less than half studying physics.) This relatively high percentage of faculty without physics degrees currently teaching the subject may be of some concern.

Full-time faculty have taught at two-year colleges for a median of 15 years. Needless to say, part-timers generally have far less experience with two-year college teaching than full-timers, despite the similarities in age profiles. As a group,

Figure 12: Teachers' educational background*

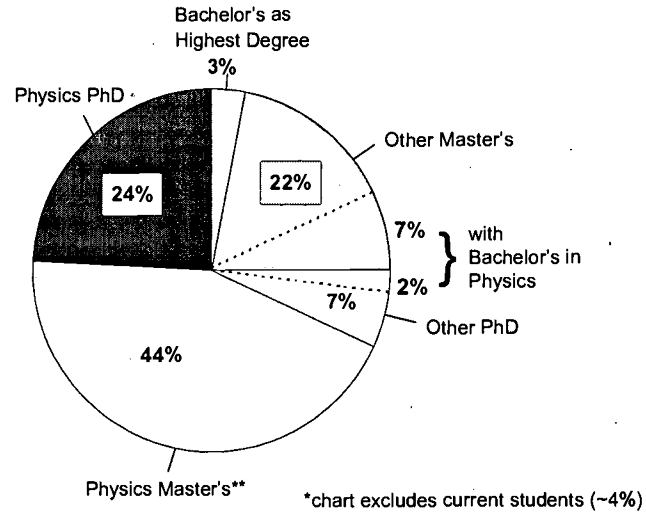


*chart excludes current students (~4%)
**including 4% with PhDs in other fields

Source: 1996 AIP Two-Year College Physics Study

part-time faculty had taught a median of five years, with a distribution strongly skewed toward lower values, one-quarter having taught for two years or less.

Seventy-nine percent of schools offer tenure, and 59% of those schools utilize a faculty ranking system. In these schools, just over half of the permanent full-time faculty had the title of professor or full professor, about one-quarter were associate professors, 15% were assistant professors, and 8% were instructors, with the remaining few unclassified. Where tenure is offered, most full-time faculty had tenure, and virtually all full-time faculty who did not have tenure were in tenure-track positions. As would be expected, tenure rates are strongly tied to years of teaching experience. This helps explain the counterintuitive finding that slightly more full-time physics faculty whose highest degree was a master's (86%) enjoyed tenure than those with a PhD (80%), since it turns out that master's-level faculty had taught for 16.9 years, while PhD-level faculty had taught a mean of 14.2 years. The lower experience levels of PhDs probably reflects the proportion of new PhDs joining the ranks of two-year college teaching due to the poor job market of recent years, a topic that will be treated in greater detail below.

Workloads and Salaries

The typical full-time course load was four courses or 15 credit hours per term. Among part-timers, 47% taught one course per term, 36% taught two, and 17% taught three or more. Full-time faculty reported that they spent an average of 18 hours teaching in class or lab. They spent an additional five hours holding office hours

and advising students, for a total of 24 hours a week spent in direct contact with students. Added to this was another 14 hours for course preparation and curriculum development, and five hours per week for additional activities and duties, including research, committee assignments, college-wide and community service, and so on.

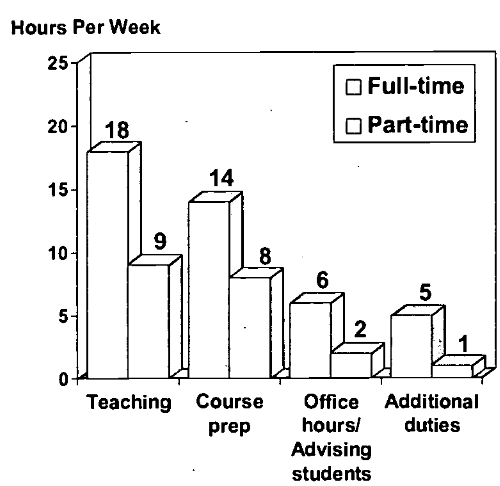
Thus, full-time two-year college physics faculty spent 43 hours a week on average doing their jobs. Of this time, 88% was spent on activities that were directly related to teaching. By comparison, faculty across all disciplines at comprehensive and liberal arts colleges reported spending 61% of their time on teaching-related activities, and faculty at research and doctoral institutions spent 41% of their time on such tasks (National Survey of Post-Secondary Faculty, 1997:39).

Responses to the AIP survey from part-time two-year college physics faculty showed them spending an average of twenty hours per week at this job, devoting essentially all of their time to teaching-related tasks. Teaching classes or labs occupied nearly half of that time, with the remainder taken up largely with class preparation. Reflecting their temporary status, virtually none of the part-timers had committee or administrative responsibilities (see **Figure 13**).

Overall, 14% of the full-time faculty reported holding an official administrative position in addition to their teaching duties. However, a far larger number of full-timers indicated that their regular faculty responsibilities required them to fulfill various administrative tasks (see **Table 3**).

Among full-time faculty, two-thirds of their courseload was devoted to physics. In

Figure 13: Two-year college physics faculty work activities



Source: 1996 AIP Two-Year College Physics Study

Table 3: Administrative responsibilities for full-time faculty

Percent of full-timers who reported:	
choosing texts and curriculum materials for the entire physics program	80
determining course offerings	59
hiring part-time faculty	32
hiring full-time faculty	27

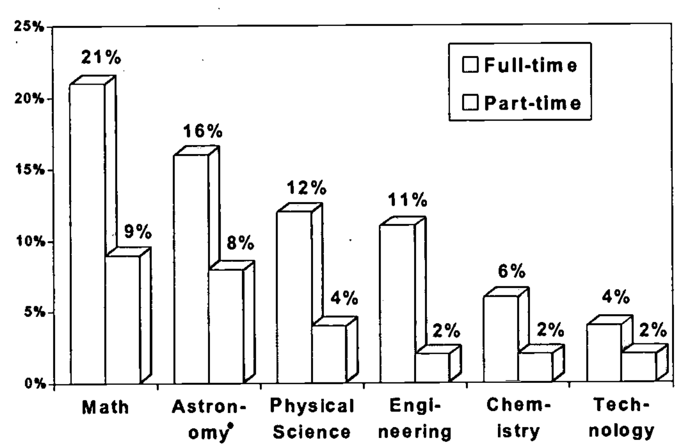
Source: 1996 AIP Two-Year College Physics Study

line with the enrollment figures presented in **Figure 6**, the most common physics courses taught by these faculty were algebra-based, followed by calculus-based physics. Somewhat surprisingly, there was very little difference between full-timers and part-timers in the types of physics courses taught. This goes against the previously mentioned pattern found in two-year college mathematics, where permanent faculty tend to reserve the calculus and other advanced math for themselves, hiring part-timers to teach the remedial and other more basic classes.

Similarly, PhD-level and master's-level physics faculty did not differ significantly in the types of physics courses they taught. However, small differences in the kinds of physics courses taught did arise between faculty with degrees in physics versus those without a physics degree, and surprisingly between those who belonged to the American Association of Physics Teachers (AAPT) and those who did not. Thus, 38% of the courses taught by those with a physics master's or PhD were calculus-based, as compared with 26% for those with no graduate physics degree. Along the same lines, 59% of full-time AAPT members taught at least one section of calculus-based physics, while only 41% of non-members did so.

As noted earlier, full-time faculty members were significantly more likely than part-timers to teach courses outside of physics. Because part-time faculty are often hired to teach one or two specific courses as needed, it is not surprising that nearly three-fourths of part-timers taught only physics. In contrast, almost two thirds of the full-time faculty taught other subjects in addition to physics. For both groups, mathematics was the most common other course taught, followed by astronomy and physical science (see **Figure 14**).

Figure 14: Percent of physics teachers at two-year colleges teaching other courses



Source: 1996 AIP Two-Year College Physics Study

Among full-timers, the likelihood of teaching just physics improves with increases in the size of physics enrollments and the number of other faculty. Just over a quarter of the full-time faculty who responded to the survey reported that they were the only physics instructors in their departments. Only 20% of these full-timers taught physics exclusively, compared to over half of their counterparts in departments with four or more physics faculty, generally at the largest two-year schools.

The median salary for full-time physics teachers was $42,000 for a 9-month academic year. This is somewhat lower than the medians of $49,000 for four-year college physics faculty and $50,000 for university faculty (Chu, 1997:7) (age and years of experience were comparable for all three groups). Interestingly, there was virtually no difference in salary between two-year physics faculty with a PhD and those whose highest degree was a master's. There was also no difference between male and female faculty once years of experience were controlled for. As expected, the key factor was seniority, with senior faculty (those with 20+ years of experience) earning a median of $50,000, compared with a median of $32,650 for those with 5 or fewer years of teaching experience. There were also the expected differences by geographic location, with faculty in the Pacific and Mid-Atlantic regions surpassing a median of $50,000, while the median for faculty in the Southern and Plains states was in the mid-to-high thirties. What was most surprising was the extent of the differences in salary by school size. Physics faculty at small schools earned a median salary of just over $35,000. As we moved up to categories of even larger schools, salaries grew steadily as well. For the top category, schools with more than 10,000 students, the median salary of physics faculty was $53,000, 60% higher than their small-school counterparts.

Allocation of Resources

Full-time faculty appear to have adequate access to on-campus workspace and computer facilities for their own use. However, the lack of adequate resources dedicated specifically for use in teaching surfaced as a problem area for many at the two-year college level. For example, the lack of support staff and material noted by department chairs earlier in this report is echoed by faculty responses. Forty-seven percent of full-time faculty reported insufficient funds for equipment and supplies, and 34% reported inadequate and outmoded labs and facilities as serious problem areas.

Similarly, laboratory or classroom support staff were available to only half of the faculty — this being the case for both full- and part-timers. Full-timers with support staff available to them received a median four hours per week of assistance. However, major differences existed with respect to financial support. Virtually all of the full-timers received funds to purchase physics curriculum materials and supplies,

although the median annual budget was just $1,500. In contrast, only a third of part-timers reported having *any* equipment budget available to them, although in some cases this may have been because funding was the responsibility of full-time colleagues or the department head.

Interestingly, there was a difference in the equipment budget by degree level, with the budget for full-time PhD-level faculty being 27% higher than for master's-level faculty. This was true even though the two groups did not differ in either the percent of their total teaching load that was physics (about 67%), or the types of physics courses they taught. The fact that full-time faculty with PhDs were more likely to teach at larger two-year colleges could be an explanation for the disparity.

Even greater differences exist between full- and part-time faculty in the allocation of resources for their own personal use. Nearly all of the full-time faculty had assigned space on campus, and almost as many reported having a computer in their office. Three-quarters had access to the Internet and/or had e-mail either on campus or at home. In contrast, part-timers had less with which to work — only half had assigned space in which to prepare for classes and meet with students, and only 27% had an office computer. However, like their full-time counterparts, three-quarters had computer access in their home, and 55% had access to computer features such as Internet and e-mail either on- or off-campus (see **Table 4**).

Professional Involvement

One major area of concern for those involved with two-year college physics programs is what is perceived as the relative isolation and lack of professional involvement among many of the faculty. As mentioned earlier, nearly half of all campuses have only one member teaching physics. Additionally, faculty may teach in more remote areas of the country, with few

Table 4: Resources available to two-year college physics teachers

	Full-time faculty	Part-time faculty
Percent who had assigned space on campus	100	53
Percent who had a computer in their office	84	27
Percent who had a computer at home	74	74
Percent who had Internet/e-mail available to them	74	55

Source: 1996 AIP Two-Year College Physics Study

opportunities to engage in professional activities, particularly if their department does not provide much funding for such activities. Of course, the advent of the Internet and the World Wide Web may help to offset this physical isolation. Still, many faculty may find virtual interchange only a partial substitute for the real thing. Our survey also found that an unusually high percentage of full-time faculty have spent their entire physics careers teaching at the same two-year college. While this may lead to stable departments, it may also reinforce isolation and lack of exposure to new approaches.

Membership in AAPT and other professional societies provides a potential channel for professional involvement and interaction with colleagues. Comparing AAPT membership records against our lists of college physics teachers provided by departments, we found that about one-third of physics faculty were members of AAPT. Not surprisingly, full-time faculty were considerably more likely than part-timers to be members — 37% compared to 17%. Furthermore, AAPT membership was strongly linked to academic background. Eighty percent of the responding AAPT members had graduate physics degrees, compared to 58% of non-AAPT respondents. Overall, 44% of the faculty with physics degrees at any level were members of the national physics teachers organization, compared to just 18% of faculty whose degrees were all in other fields. However, not surprisingly, a larger proportion of the latter held memberships in organizations like the American Chemical Society and the American Society for Engineering Education. Virtually none of the faculty with physics degrees held memberships in those organizations.

For many two-year faculty, professional activities were mainly limited to attendance at professional meetings, rather than more active types of participation which involve providing information or adding to the knowledge base in the field, either in physics or physics education (see **Table 5**). This may be one of the costs of the relatively heavy teaching loads and other responsibilities that two-year college teachers are expected to fulfill. Nevertheless, 83% of full-timers and 61% of part-timers had attended at least one meeting during the previous two years, and the median number of meetings attended by these faculty was three. In addition, just over half of full-timers and a third of part-timers had participated in workshops or mini-courses during this time period. However, less than a fifth of full-time faculty reported getting something published or receiving a grant in the previous two years.

Financial support for attending conferences and workshops was available to 85% of full-timers but to only a third of part-timers. In general, support for travel and conference fees did correlate with the number and type of activities faculty were involved in, with faculty reporting adequate levels of support playing a noticeably more active role. And, as was the case

Table 5: Professional activities of two-year college physics faculty

Percent of faculty who over the past two years:	Full-time	Part-time
attended a professional meeting	83	61
participated in workshops or mini-courses	52	34
wrote a grant proposal	31	20
Of those who wrote a grant proposal, % who received a grant	54	42
had an article published	18	26
wrote a textbook or a book chapter	11	8
took an upper division or graduate level physics course	9	13

Source: 1996 AIP Two-Year College Physics Study

with interaction with colleagues, AAPT membership also made a difference in the frequency and type of professional activities reported. Overall, two-thirds of the professionally most active respondents were members of AAPT, and this held regardless of degree level or years of experience.

The need for summer employment may also militate against professional activity since many such activities are geared to the schedules of university and four-year college faculty and are traditionally carried out in the summer. About two-thirds of two-year college physics faculty who taught full-time during the regular academic year also had summer employment, including half of the women and two-thirds of the men. While many university faculty also work over the summer, their activities are as likely to involve research as teaching, allowing more flexibility to accommodate meeting schedules. In contrast, over four-fifths of two-year college physics faculty with summer employment taught classes at the same two-year college where they teach during the rest of the year. A substantial number of the remainder taught summer courses at four-year colleges or universities. Only 4% reported doing research.

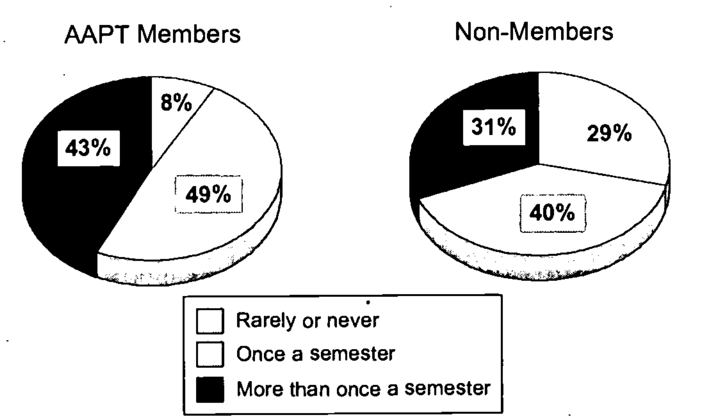
Besides being a source of professional and personal support and information on new approaches to physics teaching, professional interaction — especially with on-campus colleagues — usually has an administrative component as well. In addition to job-related issues such as course assignments, compensation, evaluation, and so on, this often includes instructional matters such as coordination of physics course offerings and their integration within the broader program of science studies. Preliminary interviews with

department personnel at several campuses as part of our study highlighted the importance of this type of coordination in terms of sharing resources and harmonizing levels of instruction (e.g., ensuring that students are getting the appropriate mathematics for doing physics problems, etc.). Thus, it was not surprising that the overwhelming majority of faculty reported a fairly sustained level of interaction with other science faculty on their campuses, with at least several interchanges per semester. Nearly two-thirds felt that they had "ample opportunities to share ideas with other faculty."

Interaction with faculty from other campuses is more likely to focus on the broader professional issues, such as keeping current on new developments in physics and physics teaching, as well as general collegial interchange. Over four-fifths of full-time faculty had at least some interaction each semester with off-campus physics colleagues. For those who are the only full-time faculty on their campus, particularly in isolated areas, such interaction would seem even more important for keeping up with the field. Among these faculty, AAPT members reported more interaction with other academic physicists than non-members, indicating the importance of professional organizations in combating isolation. Ninety-two percent of these AAPT members, compared to 71% of non-members, have such interactions at least once a semester, and 43%, compared to 31% of non-members, had more frequent interactions (see **Figure 15**). However, the higher interaction level for AAPT members fades somewhat on campuses with more than one physics teacher. This probably reflects the fact that those who have colleagues on campus have less need to interact with off-campus people through professional organizations.

Faculty with PhDs were a bit more likely to interact regularly with four-year college and university physics faculty than

Figure 15: Interaction with other academic physicists when respondent is sole full-time physics teacher on campus



Source: 1996 AIP Two-Year College Physics Study

faculty with a master's as their highest degree. One-quarter of those with PhDs had contact with four-year college and university physics faculty at least several times a semester, compared to 14% of those with master's degrees. However, this may simply reflect the continuation of professional relationships that PhD-level faculty established while working on their degrees, rather than the cultivation of new relationships based on their positions as two-year college faculty. Similarly, part-time faculty with master's degrees (many of whom also had full-time high school teaching positions) were more likely to interact regularly with high school teachers than were other two-year college faculty.

Two-thirds of the full-time faculty reported that support was available to them for program and curriculum development. However, only 46% took advantage of it. Among part-timers, only 29% had access to such institutional support, and only 12% made use of it. Full-time AAPT members, and, to some degree, women, were more likely to incorporate one or more of the innovative physics teaching approaches and resources developed in recent years. However, as **Figure 16** shows, this is not to say that large numbers of teachers used any of these materials.

Of all the new initiatives listed on the questionnaire, Microcomputer-Based Lab (MBL) and the Force Concept Inventory were most commonly cited, with about a third of women faculty and just under a quarter of men reporting at least occasional use. Another 15% of faculty (a quarter of women and an eighth of men) incorporated the Mechanics Baseline Test or Ranking Tasks into their evaluations of student understanding (see **Table 6**).

Figure 16: Institutional support for program and curriculum development

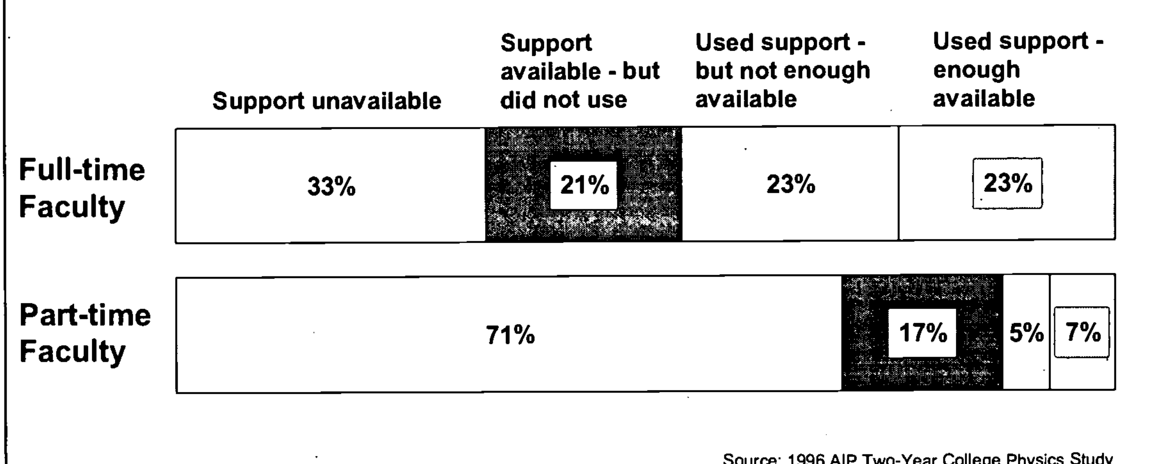


Table 6: Percent of full-time faculty using recently developed instructional techniques				
	Women	Men	AAPT members	Non-AAPT members
Microcomputer-Based Lab	33%	24%	36%	12%
Force Concept Inventory	35	22	36	7
Mechanics Baseline Test	26	14	24	5
Ranking Tasks	27	13	23	4

Source: 1996 AIP Two-Year College Physics Study

The pattern of greater use of new approaches by female faculty even extended to approaches that were less-widely employed, including Conceptual Exercises/Overview Case Studies (used by 20% of women faculty but only 8% of men) and Active Learning Projects (14% versus 8%, respectively). The only new approaches for which there were no significant gender differences in usage were Calculator-Based Labs (used by 16% of faculty overall) and two listings which were almost unknown, Comprehensive Unified Physics Learning Environment (2% overall) and courses developed as part of the Introductory University Physics Project (1% overall).

Women's generally greater awareness and use of innovative methods, as illustrated in **Table 6**, may have been due to the fact that more of them had a previous or continuing teaching background at the high school level. As a larger community, high school physics educators have been able to mount more substantial efforts with greater funding for the development of new instructional techniques.

Another possible explanation for the gender difference is that women faculty are a bit more likely to be AAPT members, who are far more likely to be aware of and use these new approaches that non-members. For example, 65% of full-timers who are AAPT members have heard of MBL and 36% report using it in their physics classes, whereas only 24% of full-time non-members have heard of MBL, and only 12% use it. (Part-timers in AAPT are less likely to have heard of these resources than full-time members are, but still are more likely to be familiar with them than either full- or part-time instructors who are not members of AAPT.) This heightened awareness is probably due both to formal programs within AAPT that try to foster new approaches to physics teaching, and to the formal and informal information exchanges that take place among members of professional associations.

Views about Work

Overall, there was a relatively high degree of career satisfaction among two-year college physics faculty, along with positive feeling about their work environment. Nearly three-quarters of full-time members say that they would "still choose to go into two-year college teaching" if they had it to do over again. However, full-time faculty whose highest degree was a master's were more likely to reflect this viewpoint (81% to 57%) than faculty with a PhD.

This finding may be related to the sense of choices and preferences felt when instructors entered their two-year college teaching careers. As **Table 7** shows, a larger proportion of PhD-level faculty, especially part-timers, would have preferred to work at a four-year college or university than would master's-level faculty. Nor is it surprising that PhD-level faculty were more likely to feel under-employed than other faculty did. Along the same lines, master's-level faculty were more likely to say that they preferred physics teaching over physics research, which fits with the finding, mentioned above, that PhD-level faculty were more likely than master's-level faculty to complain about the lack of resources for doing research.

Regardless of degree level, employment status or gender, faculty expressed a definite preference for teaching physics over other subjects, although those with physics degrees did so more than other teachers, by 83% to 58%. Not surprisingly, full-time AAPT members are also more likely to prefer teaching physics to other subjects than non-members (84% vs. 68%).

Where a teacher was in his or her career stage also affected responses on some of these same issues. Full-timers in the first ten years of their career were more likely to

Table 7: Two-year college faculty views of their work, by type of appointment and level of highest degree

	Full-time		Part-time	
	MS %	PhD %	MS %	PhD %
Would rather be teaching at a four-year college or university	16	36	22	45
Consider themselves to be underemployed	17	51	42	61
Prefer physics teaching over physics research	88	70	74	53
Prefer physics teaching to teaching other subjects	78	80	77	81

Source: 1996 AIP Two-Year College Physics Study

say that they would rather be teaching at a four-year college (35%) and that they considered themselves underemployed (40%). By contrast, less than one-fifth of teachers with more than 20 years experience would rather be teaching at a four-year college and a similarly small proportion felt underemployed.

Some of this difference may be attributable to the fact that 28% of the more recent faculty recruits held doctorates in physics, compared to 20% among those with ten or more years of experience. This may occur because doctorate holders may have better career alternatives, and thus fewer may stay around for ten years or more. However, some of the difference is also likely due to the difficult job market for physics PhDs in the 1990s.

Further evidence that this is so, especially among part-timers, comes from a survey conducted for the National Science Foundation in 1989. According to the NSF study, 28% of full-time two-year college physics faculty held doctorates in physics or some other field compared to 33% found in the AIP survey, a small change over the course of seven years. However, the difference is more extreme for part-time physics faculty. In 1989, NSF reported that 14% of part-timers held doctorates, while AIP's data indicate 35% did. The appearance of larger numbers of PhD-holders among the members of part-time physics faculty thus seems to correspond closely to the period when the job market for new physics PhDs was at its nadir.

Teachers of different backgrounds also displayed some differences of opinion on the qualifications necessary to teach two-year college physics. PhD-level faculty felt more strongly than others that only people with a graduate degree or the equivalent in physics were qualified to teach it at the two-year college level, with about three-quarters holding this view. Still, even among part-timers with master's degrees, around half also agreed with this statement. The strongest difference, predictably, revolved around the teachers' fields of graduate study. Four-fifths of those with a graduate degree in physics agreed that only people with credentials like theirs should teach physics, compared with about two-fifths of those with a physics bachelor's as the highest degree and only one-fifth of those with no physics degree.

Overall, faculty assessment of potential problem areas in their work did not differ substantially by degree level, AAPT membership status or gender. The major areas of complaint for all centered on inadequate teaching resources and students' lack of preparation and interest (see **Table 8**), although the latter finding stands in curious opposition to statements by two-thirds, full- and part-timers alike, that their main satisfaction in two-year college teaching was working with students.

Table 8: Problems cited by two-year college physics faculty as serious

	Full-time %	Part-time %
Students' weak math backgrounds	53	44
Insufficient funds for equipment and supplies	47	31
Inadequate space for lab, or facilities outmoded	34	24
Students' lack of interest in physics	27	22
The amount of time required to prepare labs	24	14
Teaching load too heavy	22	5
Lack of resources for doing research	18	16
Too many non-teaching responsibilities	16	3
Lack of support from department or division administration	13	9
Classes too large	4	6
Lack of support from other faculty in department or division	4	5
Pressure to conduct and publish research	1	2

Source: 1996 AIP Two-Year College Physics Study

Full-Time Faculty — Career Paths and Attitudes towards Work

Once they begin teaching at a two-year college, physics faculty seem to "stay put," rather than move from one institution to another. Full-time permanent faculty had taught at the two-year college level for a median of 15 years, 13 of those years at their current college. Even part-timers showed little movement from school to school, having taught for a median of 5 years at the two-year college level and 4 years at their current school. This high level of career stability was found among faculty at all career stages, across all levels of experience, but was most pronounced for those with 20 or more years of experience (40% of all full-timers), who had taught a median of 26 years, 25 of them at the same institution. These faculty were also more likely to have been two-year college teachers for their entire careers than other faculty were.

In line with the findings mentioned earlier on career satisfaction, nearly three-quarters of the respondents who described their motivation for becoming two-year college teachers cited positive reasons. For about 30% of the full-time faculty, two-year college teaching was the only type of professional position they had ever held. As noted above, this number increased to 39% for those who had been teaching for 20 or more years, compared to about a quarter of all other faculty. There are two probable causes for the difference: first, individuals who had work experience prior to two-year college teaching may be more likely to leave, reflecting both greater opportunities in alternative settings and perhaps greater ambivalence about their current career choice; second, as discussed in an earlier section, during the 1970s physicists experienced a poor job market similar to that which existed in the early 1990s. In such periods, a greater proportion of physicists may have become two-year college teachers right out of graduate school and then became set in that career and never looked elsewhere.

This scenario is also consistent with the relatively large proportion of veteran teachers who reported making the decision to teach at the two-year college level while they were still students. Forty-one percent of full-time permanent faculty with 20 or more years of experience did so, compared to only about 20% of other full-time faculty. However, older teachers did not appear to feel "stuck" in their jobs. In response to the question, "Why did you decide to become a two-year college teacher?" they, as much as or even more than their younger counterparts, cited positive reasons related to the enjoyment of teaching — and of teaching physics in particular, along with a preference for teaching over research. Many also valued the flexibility and material benefits of two-year college teaching. Only about 14% of those full-timers who had been teaching for 20 or more years gave negative reasons for becoming a two-year college teacher, with statements such as: "There was nothing else available at the time..." "My old job was worse..." or "It was the best job I could get without a PhD."

Similarly, only a small percentage of full-time teachers who are in mid-career (10 to 19 years of experience) cited negative reasons for going into two-year college teaching. Among those in their first decade of teaching, the proportion offering negative reasons rises moderately, to about one-quarter. It is likely that this higher percentage stems in part from those who reluctantly entered two-year college teaching.

Such entrants are also more prone to leave the job after a few years, creating the well-documented pattern in teaching of high turnover during the first few years. Indeed, for those survey respondents in the first decade of their career who gave negative reasons for deciding to become two-year college teachers, a third did not plan continue in their positions until retirement, compared to 14% of those in their first 10 years of teaching who gave only

positive or neutral reasons, and about 4% of everyone else. Clearly, many of the older counterparts of these more reluctant recruits have already been weeded out from the ranks of those still around at later career stages.

Differences in responses by degree level also go hand in hand with the above scenario. Thirty-six percent of the full-time faculty with master's degrees arrived at the decision to become two-year college teachers while in school, compared to only 20% of those with PhDs. Conversely, 16% of the full-time faculty with master's degrees and 34% with PhDs made the choice after starting their initial job search. These differences suggest that for master's-level faculty, the choice to become a two-year college teacher was somewhat more likely to have been pre-planned, while for PhDs the choice may have more often resulted from an absence of other employment options.

Still, overall, the most striking finding is how few faculty planned to be two-year college teachers when they were in school. Nearly half of the full-time faculty only decided to become two-year college teachers after starting out in a different career. **Table 9** illustrates where these teachers began before switching to two-year college teaching, breaking it out further by gender and degree level. As shown in the table, men were somewhat more likely than women to have started out in private industry, while more women began as teachers, especially in high schools. Not surprisingly, doctorate holders were more likely to have emigrated from four-year colleges, while master's-holders tended to come from high schools and private industry. Overall, full-time physics faculty who started out elsewhere spent a median of 4 years in these initial positions.

As noted earlier, only about 7% of full-time faculty had plans to leave two-year

Table 9: Initial employer of faculty starting out in different jobs, by gender and highest degree

	Highest Degree			
	MS	**PHD**	**Women**	**Men**
High school	35	12	34	26
Four-year college/University	13	46	27	22
Private industry	34	26	23	34
Other	18	16	16	18
	100%	100%	100%	100%

Source: 1996 AIP Two-Year College Physics Study

college teaching before they retired. Two-thirds of PhD-level faculty who planned to leave hoped to find positions at four-year colleges or universities, and most of the rest aimed to go into private industry. Master's-level faculty who planned to leave divided their choices evenly between four-year colleges/universities (perhaps after returning to earn their PhDs) and private industry. For those faculty, the main reasons for leaving were better pay, the opportunity to teach at a different level, and increased potential for professional growth. For PhD-level faculty, better pay was secondary to the desire to teach at a different level and increased potential for professional growth (see **Table 10**). The desire to engage in research does not seem to play a major role in the decision to leave, except among PhDs who aim to transfer to a four-year college or university.

The low prospects for turnover found among full-time two-year college physics teachers, coupled with the prior lack of career mobility and the relatively high level of job satisfaction, suggests a stable and relatively healthy occupational outlook for this segment of the physics community. However, more serious concerns become readily apparent when we turn to the career paths and conditions of part-timers, discussed below.

B. PART-TIME FACULTY

As noted above, in many ways part-time faculty exhibit different characteristics and face different hurdles than their full-time counterparts. Of particular concern are the disparities noted throughout this report in integration into their departments, allocation of department resources, teaching-related interaction with physics and other science colleagues, and compensation. These factors contribute to a work environment that tends to marginalize part-timers. The fact that they often teach evening courses after the full-time faculty have left for the day may further hinder part-time faculty from interacting in a substantive way with other members of their departments.

Table 10: Reasons for wanting to leave two-year college teaching (full-time faculty only)

	Highest Degree	
	MS %	PhD %
Better pay	25	14
More opportunity to conduct research	0	18
Opportunity to teach courses at a different level	29	31
Increased potential for professional growth and advancement	21	27
Tired of teaching; need a change	7	5
Other	18	5

Source: 1996 AIP Two-Year College Physics Study

Compensation is one of the areas of greatest contrast. Part-time physics faculty were typically paid by the credit hour or by the course. Their median earnings were $500 per credit hour or $2,000 per course. As noted previously, the typical full-time course load is fifteen credit hours or four courses per semester. If part-time faculty taught full-time loads at these rates, they would earn around $8,000 per semester or $16,000 in a nine- or ten-month academic year—little more than a third of the median salary for full-time permanent faculty. In addition, while it is true that part-timers have few non-teaching responsibilities, it is also true that they receive few, if any, benefits in the form of health insurance, paid leave, or retirement contributions. Bearing in mind that full-time faculty reported devoting less than 15% of their work time on average to non-teaching activities, this difference in compensation rates is quite substantial.

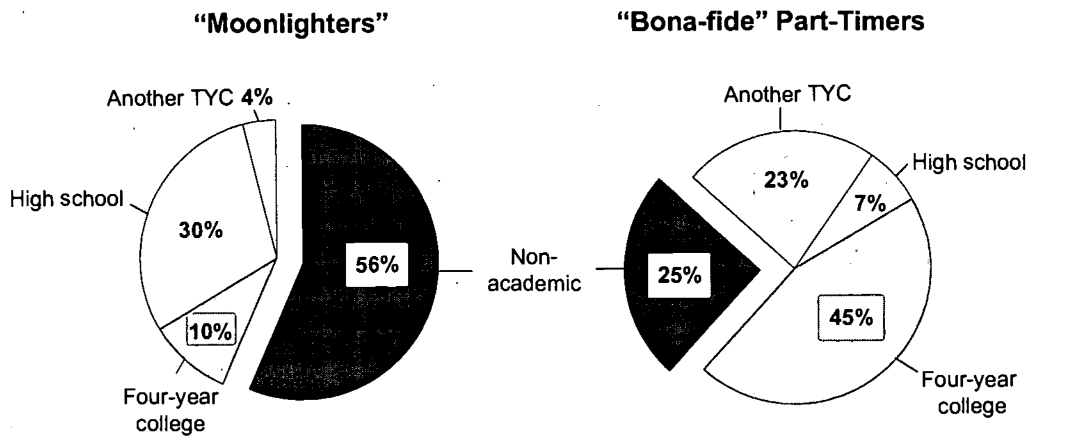
"Moonlighters" and "Bona-fide" Part-Timers

Virtually all of the full-time faculty viewed their two-year college teaching positions as their primary jobs. Only about 15% held second jobs, essentially all of which were part-time, primarily in four-year colleges/universities or private industry. Part-time faculty, in contrast, split evenly into two distinct groups, differentiated by their occupational status beyond the two-year campus. Fifty-two percent held an additional full-time job. For the purposes of our analysis, these faculty were placed into a category labeled "moonlighters."

The remaining 48% either held no other job or only another part-time job, and were placed for analysis purposes in a category labeled "bona-fide" part-timers. (In order to remove those whose current status was still peripheral to their long-term occupational outlook, part-timers who were also currently students, along with those over the age of 65, who are likely retirees, were excluded from this analysis.) The categories were drawn to try to separate those part-timers who teach part-time involuntarily and whose employment situation is precarious, from those who have a regular "career" job and have chosen to teach part-time to broaden their professional activity or to augment their regular salary. It is worth noting that among the 46% of bona-fide part-timers who held other jobs (by definition also part-time), the vast majority were other teaching positions (primarily at four-year schools). In contrast, the full-time jobs held by the moonlighters were approximately evenly split between academic and non-academic positions (see **Figure 17**).

In many respects, we find that moonlighters more closely resemble full-time faculty than they do bona-fide part-timers (see **Table 11**). For one thing, moonlighters exhibited somewhat greater job stability, having been two-year college teachers for a median of 7 years (5 at the same school), while the other part-timers had taught for a median of only 3 years. More surprisingly, given their dicier career

Figure 17: Other positions held by part-time physics faculty



Source: 1996 AIP Two-Year College Physics Study

situation, bona-fide part-timers tended to have greater academic credentials than either the moonlighting part-timers or the full-time faculty, with almost half of them holding a PhD and a third with a PhD in physics.

Another area of significant difference between the moonlighters and the bona-fide part-timers was gender. While only 7% of the moonlighters were women, a percentage comparable to full-time faculty, women constituted three times that percentage among the bona-fide part-timers. This may help to explain why only one-third of the male part-timers viewed two-year college teaching as their primary jobs, compared to over 60% of the part-time women.

Part-Timers' Professional Involvement

One area of great concern is the extent of professional involvement of part-time faculty. Here as elsewhere, it appears that moonlighters more closely resemble full-timers than bona-fide part-timers in their level of involvement (see **Table 12**).

In addition to exploring faculty participation in professional functions, the questionnaire contained a number of items that asked directly about the level and frequency of interaction with other science educators. Not surprisingly, part-timers of all stripes appeared to have lower levels of professional interaction with on-campus colleagues than do full-timers. Thirty-seven percent of part-timers met with other physics faculty on their campus weekly or more often, compared to 68% of full-timers. Similarly, only 14% of part-timers met at least weekly with on-campus faculty from other science, engineering, and technology disciplines, compared to 51% of full-timers.

This difference is undoubtedly directly related to the different roles fulfilled by

Table 11: Full-time and part-time two-year college physics faculty characteristics			
	Full-timers	**Moon-lighters**	**Bona-fide part-timers**
Number of respondents	*1007*	*114*	*125*
BACKGROUND			
% female	10	7	21
% with any physics degree	79	80	82
% with physics master's (not including those who also have a physics PhD)	46	46	33
% with physics PhD	23	21	34
% with any PhD	33	32	48
Median age	52	48	49
TEACHING ASSIGNMENTS AND EXPERIENCE			
Mean physics sections taught	2.2	1.1	1.5
Median years teaching at any TYC	15	7	3
Median years teaching at this TYC	13	5	3
Median salary	$42,000 per-year	$2,000 per-course	$1,946 per-course
PROFESSIONAL ACTIVITIES			
% with no reported professional activities in the past 2 years	8	13	27
% scoring in the lowest category of the professional activities scale	26	26	50
% with low level of contact with faculty members from any institution	6	18	18
% with no contact with **physics** faculty members at other institutions	18	30	36

Source: 1996 AIP Two-Year College Physics Study

full- and part-timers in two-year colleges. As noted earlier, full-time faculty tend to have, as noted earlier, far more administrative duties, including involvement in committee meetings, curriculum planning, and the like. Part-timers generally show up on campus to teach their classes, perhaps meet with students, and then leave. Indeed, the extent to which part-timers are isolated from involvement in curricular and programmatic discussions may have an impact not only on their personal interaction, but

Table 12: Professional activities of two-year college faculty over the past two years			
	Full-timers	**Moon-lighters**	**Bona-fide part-timers**
Number of respondents	*1007*	*114*	*125*
% with any professional activity over the past 2 years	93	87	73
% who attended more than one professional meeting	66	67	36
% who attended a minicourse or workshop for physics educators	52	38	28
% who attended more than one minicourse or workshop for physics educators	26	22	11
% who wrote a grant proposal	31	25	14

Source: 1996 AIP Two-Year College Physics Study

also on the integration of the courses that they teach with the rest of the departmental program. Preliminary follow-up interviews with department personnel indicate that this may especially be true for part-timers who teach evening courses, as well as generally in departments with less effective coordination and communication channels.

But, as we noted earlier, administrative coordination is only one of the benefits of professional interaction. The opportunity to compare notes and learn about new developments in physics and pedagogy is another. Here, part-timers are at least as in need of interchange as full-timers, and even the moderately-higher levels of isolation reflected in the responses of the former are likely to have serious consequences.

For example, on the broadest level, only about half the part-timers described themselves as having ample opportunity to share ideas with other faculty, compared with 66% of full-timers. More specifically, 30% of moonlighters and 36% of bona-fide part-timers had either no or only very sporadic contact with physics faculty at other institutions, compared to only 18% of their full-time colleagues.

The one exception was the small group of part-timers who were AAPT members, whose interaction with others, including high school teachers and four-year college faculty, exceeded that of almost all other groups. This finding is likely a result of the opportunities for interaction provided by AAPT, but it may also reflect the kind of teacher that AAPT attracts. In the case of interaction with high school teachers, it may also stem from the high number of part-time AAPT members who are also high school teachers (46%, compared to 13% for part-time non-members).

Part-Timers' Views of their Work

The strongest indicator of dissatisfaction on the part of the bona-fide part-timers especially is the high percentage who reported that they considered themselves underemployed (see **Table 13**). Over two-thirds agreed with this sentiment. The corresponding percentage among the moonlighters is much lower, which is not surprising given that they have full employment elsewhere. However, it is still substantial at 31%, which is close to the rate for full-time faculty. A higher proportion of bona-fide part-timers than the other two groups also indicated that they would prefer to be teaching at a four-year school.

Another indication of the sense of precariousness in their positions among part-timers of both types was the finding that, despite their relative lack of "job hopping" in the past, most part-timers displayed little confidence in their job security. Less than one-quarter of bona-fide part-timers and 44% of moonlighters felt that their job was secure for the foreseeable future, compared to 80% of full-timers, most of whom have tenured status.

On the issue of the status of part-timers in the department, there was far less of a sharp divide between full-timers, moonlighters, and bona-fide part-timers than one might expect. Around half of the respondents agreed that part-timers were undervalued, with part-time faculty only a bit more likely to concur than full-time professors. In addition, part-timers with a PhD were less likely to hold this view than those whose highest degree was the master's, perhaps because the doctorate confers an added status that is not enjoyed by those with lower-level degrees.

Table 13: Views of two-year college teaching

	Full-timers	Moon-lighters	Bona-fide part-timers
Number of respondents	*1007*	*114*	*125*
% who consider themselves to be underemployed	29	31	68
% who would rather be teaching at a four year college or university	23	26	39
% who feel job is secure for the foreseeable future	80	44	23
% who feel part-time faculty are undervalued in their department	38	46	53
% who agree that TYC physics faculty are well respected by the rest of the physics community	21	21	22

Source: 1996 AIP Two-Year College Physics Study

One area in which part-time faculty showed generally *lower* levels of dissatisfaction was in their assessment of work conditions. Part-time faculty generally reported the same or fewer problems in areas such as instructional resources, departmental support, and student preparation. In part, this may be due to different initial expectations and in part to the fact that full-time faculty are more involved in the administration of day-to-day operations in their departments, and thus spend more time confronting these issues.

Career Patterns among Part-Timers

Part-time faculty generally came to two-year college teaching after having started out in a different career. Moonlighters had spent a median of 13 years at their full-time jobs, significantly longer than they had spent at their part-time two-year college jobs. But, even among full-time faculty, almost half reported that they made the decision to teach at the two-year college level after starting out in different careers.

What led individuals who already held full-time positions to take on the added role of part-time two-year college teachers? Around half of all three groups cited their love of teaching or the rewards of working with students. However, only among the moonlighters was salary an important consideration, with 28% citing this reason, compared to only around 5% of the full-timers or bona-fide part-timers.

One further difference was that bona-fide part-timers were a bit more likely to cite neutral or negative reasons for going into two-year college teaching, indicating either a change in personal circumstances or noting that there was nothing else available at the time. Nevertheless, even among this group, fewer than one-fourth cited primarily negative factors in explaining their entrance into two-year college teaching. Overall satisfaction levels for all part-timers were only a bit lower than the high levels reported by full-time faculty, and a majority reported they would still go into two-year college teaching if they had it to do all over again.

As remarked earlier, almost all full-time faculty intend to continue in their positions until retirement, and this was equally true regardless of gender. Even among many part-timers, there was evidence of a long-term commitment. Curiously, however, women were less inclined than men to have such plans. Nearly half of part-time women, but just over a quarter of part-time men, indicated that they probably would not teach at the two-year college level until they retired. This difference might spring in part from the age difference between women and men — part-time women were, on average, seven years younger than part-time men and had significantly fewer years of two-year college teaching experience (6 years vs. 8.2 years). Younger, less experienced teachers were generally less likely than their older, more experienced counterparts to say they planned to continue in their current positions until retirement.

V. SUMMARY

The preceding sections offer a sketch of two-year college physics faculty as a small but generally vibrant group of professionals, working away from the central arenas of the established physics community and its concerns. Their primary focus is not research at the frontiers of new science, but rather the challenge of making the methods of scientific inquiry and the basic principles of physics comprehensible and exciting to students who have been oriented away from academics and towards practical and marketable skills. The collective portrait offered by their responses to the AIP survey discloses areas of great strengths and successes, and also areas of daunting problems and deep concerns for the future.

On the positive side, we found generally high levels of job satisfaction and extraordinary career stability, despite the fact that many two-year college physics instructors had arrived relatively late at their career choice. At the center of their ranks was a strong core of committed, professionally active teachers, whose responses and comments reflected a deep involvement in their craft, a familiarity with the latest instructional innovation, and a familiarity with and empathy towards their students, like themselves often regarded as outside of the academic "mainstream." High levels of communication with physics colleagues and cross-fertilization with counterparts in other science disciplines were maintained despite often limited resources and physical and organizational barriers.

However, juxtaposed against this highly integrated group was an even larger segment of the community that appeared quite isolated (sometimes voluntarily so), with minimal interaction with other members of the two-year college physics teaching community and little familiarity with new teaching approaches or resources. Besides isolation, there were a number of other areas of concern as well: the marginalization (and probably the rising use) of part-time instructors; the same underrepresentation of women and minorities that plagues the discipline at all levels; generally low levels of administrative support for facilities, equipment and pursuit of professional development; and a widespread sense of separation from and lack of acceptance by the broader academic physics community.

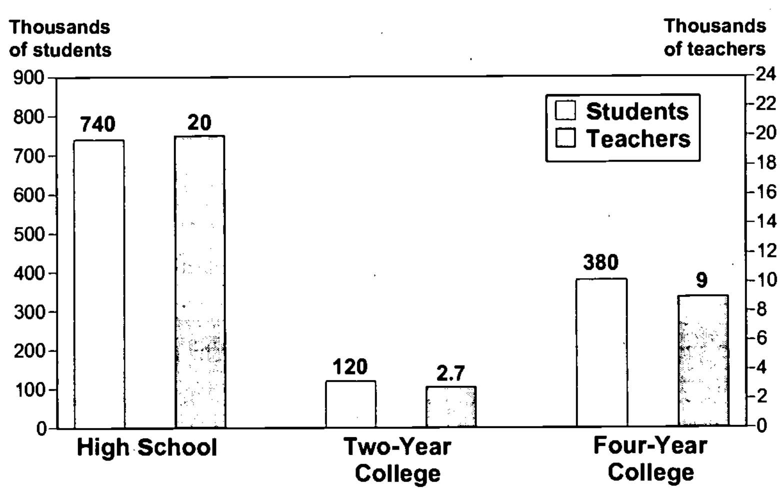
These last sentiments seemed to be shared across-the-board. Even teachers who were active in professional organizations tended to cluster together with two-year colleagues. In part, this may be in reaction to their relatively sparse numbers compared to teachers at the high schools and four-year colleges and universities (see **Figure 18**). But, whatever the cause, the lack of communications among physics educators at different levels seemed all the more consternating given the many parallels between their programs and those offered at other academic levels.

One of the strongest areas of correspondence we found was curricular — the similarity between two-year college courses and the introductory classes offered in four-year physics programs. This held even though there were major differences in the characteristics of the student populations served. Thus, the survey responses of department heads indicated that 28% of the courses offered in the two-year physics programs were calculus-based, 50% were algebra- and/or trigonometry-based, and 22% required little or no mathematics background from the students, closely matching the enrollment numbers for students that teachers reported. Few courses seemed designed specifically for the occupational goals of a strictly two-year college student population.

What is most surprising is that responses from four-year college and university physics department chairs on the AIP's annual Enrollment and Degrees survey that same year indicated that students taking introductory physics at *those* institutions were only slightly more likely to sign up for the mathematically more demanding variants. In fact, in those four-year schools that did not offer a graduate program in physics, the enrollment distribution seemed, if anything, *less* advanced, with 32% taking calculus-based physics, 36% taking the algebra/trigonometry-based course, and 32% taking physics that required only minimal math background.

This similarity in the types of courses offered may be related to the findings presented earlier on career paths, which suggested that few two-year college physics teachers start out with that career goal in mind. While there were major differences in educational background —

Figure 18: Number of students taking at least one physics course (left scale) and number of physics teachers (right scale)



Source: 1996 AIP Two-Year College Physics Study

virtually all four-year college faculty had earned a PhD while the majority of two-year faculty had gone no further than a master's — for the most part, two-year teachers like their four-year counterparts had trained in graduate physics programs that were primarily oriented to turning out researchers. Little energy is spent in these programs to help graduate students learn how to be effective instructors, and, in the rare instances where pedagogical skills are addressed, they are certainly not geared towards a two-year environment.

Moreover, the influence of the two-year faculty's own experiences as students is probably exacerbated by the fact that many, and often the most promising and responsive, students in their classrooms are those intent on transferring to four-year schools. Given their own goals and the conditions of transfer, these students need to complete the standard four-year college introductory course. However, the prevalence of this pattern may actually serve to hinder the development of new courses specifically designed for what is unique to two-year institutions, namely students who are not looking to transfer and are seeking an introduction to physics appropriate to their different vocational goals.

The dearth of courses specifically designed for two-year college students may have even greater impact because of the poor math background which many students bring with them from high school. In their 1995 study of undergraduate-level mathematics programs, the Conference Board for Mathematical Sciences found that over half of two-year college mathematics enrollments were in remedial courses, primarily basic arithmetic and elementary- and intermediate-level high school algebra (Loftsgaarden *et. al.*, 1997:91). It is no surprise then that weak student mathematics background was the number one problem cited by physics teachers, with half describing this as a serious problem. Thus, while the two-year college faculty's teaching orientation, classroom experience and small classes should all foster learning among students specifically aiming at a two-year college credential, the lack of physics courses designed to meet their specific needs may hamper it.

As noted earlier, many of the factors enumerated above tend to remove physics from the mainstream of two-year college education, or to keep it on the sidelines of the broader academic physics community. Still, many of the survey responses and comments of two-year physics faculty, along with observations gleaned from department visits, professional society meetings and publications, also revealed the presence of a core group of energetic innovators and evidence of a number of ambitious attempts to fashion a curriculum and instructional approach that responds to the unique features of the two-year college environment. Equally important were programs (such as AAPT's TYC21) which aimed to address long-standing issues of isolation in the widely scattered two-year physics community, along with the demor-

alization that stems from insufficient resources and administrative support, inadequately-prepared students, and low regard from many physicist colleagues.

What these efforts seemed to show is that relatively small expenditures of resources and activity can, and often do, produce re-energized and rededicated teachers, and ultimately more effective classroom learning. However, a look at similar programs introduced over the decades suggests that, without continuity, sustained resources, and follow-through, both the programs and their beneficial the effects on faculty and students are likely to evaporate. The relatively low utilization rates of some of the highly creative and well-regarded recent innovations listed on the questionnaire indicated that, in addition to good ideas and seed money, enduring support will be needed to firmly establish these initiatives and realize their real potential.

APPENDIX A — PREVIOUS STUDIES

As noted in the introduction to the main report, studies that addressed two-year college physics education have been few and far between. Perhaps the most comprehensive such study with an explicit physics component was undertaken by Mooney (1980) with funding from the NSF. It included both a curriculum assessment and a faculty survey. The curriculum assessment utilized a sample of 175 two-year schools, stratified by type of institutional control, geographic region and size of institution. Among other things, the study made a strong effort to locate physics-related courses taught outside of physics departments. While there were problems associated with the somewhat imprecise and varying definitions of course type, the research still sufficed to provide the broad outlines of the curriculum then in place.

The faculty survey had broad objectives, focusing on a wide range of issues such as teachers' goals, course levels and functions, types of instruction used, methods used to evaluate students, faculty educational background and teaching experience, and the types assistance available to faculty. Unfortunately, the survey was part of a wider survey of instructors across many science fields, and out of 1,275 science faculty responding to the survey, only 45 turned out to be physics teachers. Thus, the data permitted only the most general of comparisons between physics and other sciences such as chemistry and biology at two-year colleges, and provided little opportunity to delve into the specifics of physics teaching or the backgrounds and viewpoints of its practitioners.

A more recent survey, sponsored jointly by the NSF, the U.S. Department of Education, and the National Endowment for the Humanities, was undertaken in 1989. The findings were summarized in *Science, Mathematics, Engineering and Technology in Two-Year and Community Colleges* (Cahalan, Farris, & White, December 1990), one in a series of Higher Education Survey Reports. This survey provided broad-based statistical estimates for several key parameters — for example, the proportion of institutions offering programs in each field, the mean number of faculty per institution, and the percentage of the faculty with PhDs. The 323 institutions in this survey were selected to represent all two-year colleges in a panel of 1,093 institutions of higher education maintained by the Higher Education Surveys (HES) System.

Among the major findings on physics were that 85% of the two-year colleges reported that they offered physics courses (98% of the public institutions and 51% of the private institutions). Thirty-eight percent of the physics faculty were described as holding part-time appointments, and 28% of the full-time physics faculty and 14% of the part-time physics faculty reportedly held doctorates. Unfortunately, the survey seems

to have treated large multi-campus systems as a single unit. By not separating out the many smaller sub-campuses that are part of public multi-campus systems, the study appears to have produced a figure for the proportion of two-year sites (especially public campuses) offering physics that is unrealistically high. Ironically, at the same time, the lack of direct contact with these smaller campuses is probably also responsible for what seems to be an undercount in the overall number of physics faculty.

Finally, while the study gathered detailed information on programs as a whole, it was a survey of institutions, represented by science coordinators or division heads, rather than a survey of faculty members. As a result, little or no information was gathered regarding faculty working conditions, the nature and quantity of courses taught, opportunities for professional development, relationships with the community and local industry, student characteristics or similar aspects of their work.

A much more detailed and focused effort was undertaken by Judith Tavel, a physics professor at Duchess Community College in New York, in 1990 and amplified in 1993 (Tavel, 1995). These surveys, utilizing mailing lists maintained by the American Association (AACC) of Community Colleges, were mailed to college presidents who were requested to forward them to the appropriate departments or individuals. The first survey sought information about number of faculty, number of contact hours, degree attainment, course offerings, course loads, availability of laboratory assistants, and so on. Responses were received from 28% of the institutions. Over the course of the next four years, data were collected from an additional 39% by various non-systematic means.

In 1993, a more comprehensive eleven-page questionnaire was sent to all two-year colleges on the AACC mailing list. Designed to probe deeper into issues that were raised in the initial survey, this effort yielded a 20% response rate. Although these low response rates, coupled with the fact that a large proportion of the returns were gathered "informally," means that caution needs to be exercised in generalizing the findings, the information obtained from them still provides a rich foundation for further study.

A sprinkling of other information is available about physics programs at the two-year level, much of it gathered "on the side" in the course of initiating and sustaining networking and support programs for physics faculty over the decades. The most recent and comprehensive source of information has emerged from the TYC21 Project *(The Two-Year College in the 21st Century)*, an effort to develop a network of physics faculty at the two-year level that was inaugurated by the American Association of Physics Teachers (AAPT) with funding from the NSF. The information provided by faculty on their applications, along with the records of meetings and workshops, provide a useful lode of information, feelings, and viewpoints on the

issue of isolation and on the general conditions faced by two-year level physics faculty. Other, similar sources of mostly qualitative data on two-year physics come from the records of the AAPT Two-Year College Committee and the committees and forums of the American Physical Society (APS) that focus on physics education. A close working relationship with interested groups from both of these organizations provided a good deal of the impetus for initiating the current study.

The sparse data that are available have also served as foundation for a series of policy workshops and reports that have been conducted by NSF since the late 1980s in response to recommendations made in the 1986 report of the National Science Board Task Committee on Undergraduate Science and Engineering Education (NSB 86-100). These workshops brought together representatives of two-year colleges, four-year colleges and universities, professional societies, and the business community to identify key issues in two-year college science, technology, engineering, and mathematics education and develop recommendations for improvements. The first Workshop on Science, Engineering, and Mathematics Education in Two-Year Colleges (NSF 89-50) was held in 1988 to identify the needs of two-year college science and engineering programs. The recommendations that came out of this workshop provided the focal points for subsequent workshops. The second workshop, held in 1991, resulted in the report *Matching Actions and Challenges* (NSF 91-111). Among the recommendations made was a call for the discipline-based professional societies to play a more prominent role in faculty development and curriculum innovation. The third workshop, summarized in the report *Partners in Progress* (NSF 93-64), focused exclusively on strategies to enhance relationships between the professional organizations and two-year college faculty. Seventy-four scientists, engineers, and mathematicians, representing 24 professional societies, (American Institute of Physics member societies APS, AAPT, the American Geophysical Union, and the American Astronomical Society) all participated in the workshop.

APPENDIX B — METHODOLOGY FOR THE STUDY

The goal of the AIP study was to first to map out the dimensions of physics programs and curricula at the two-year level, and then to delve in detail into the backgrounds, teaching practices, experiences, and viewpoints of the faculty who taught the subject at this level. Using rough approximations derived from the earlier studies discussed in **Appendix A**, it was estimated that somewhere around three thousand individuals taught physics courses at the two-year level in the United States in a given academic term. Since our ability to identify, much less obtain a response from, these teachers was far from certain, and since we were also interested in developing a directory to use as a networking tool, we decided to attempt a census of the entire population.

In order to reach these fâculty, we first had to identify the campuses where physics was taught, and for this, we needed to acquire a complete and up-to-date list of campuses. This turned out to be no easy task, for a number of reasons. The most complete existing list of post-secondary institutions was the recently restructured Integrated Post-Secondary Educational Data System (IPEDS), developed and maintained by the U.S. Department of Education's National Center for Education Statistics. While IPEDS included a vast number of public and private institutions, close examination and comparison with other sources indicated that some state and local systems, composed of anywhere from two to two dozens separate campuses, were represented by only a single entry, that of the parent campus or a central academic office. We were interested in the availability of physics (and the presence of physics teachers) at each separate campus, and we were concerned that contact with the administrative center would not yield complete information about each instructional locale. As it turned out, comparison with earlier studies that relied strictly on IPEDS seemed to justify these concerns.

As a result, we used IPEDS as a base, selecting all public two-year schools offering an associate's degree (but no higher degree), along with degree-granting private schools which were accredited either by a regional accrediting agency recognized by the U.S. Department of Education or by a private accrediting agency devoted to science or technical education. (This allowed us to eliminate thousands of small proprietary schools offering two-year awards in a single, non-technical field, such as business colleges and beauty schools, which we felt were highly unlikely to offer a course in physics.) We also called the 330 schools which were listed as having a total student enrollment exceeding 5,000, and asked them to send us their school bulletin, course catalogue or course schedule, which we used for double-checking administrator response, as well as a general information

source and guide to the institutional environment. We were sent material from close to 90% of these large schools, with a combined enrollment of around four million, nearly three-fourths of the total enrollment for all two-year schools.

We supplemented the IPEDS list in two ways: first by using the membership list of the American Association of Community Colleges (AACC), an organization of more than one thousand mostly-public two-year schools whose database makes explicit the parent-daughter relationships in campus systems; and second, by asking all schools we subsequently contacted to indicate all other campuses in their systems. The resulting list of two-year schools initially contained 1,957 distinct campuses that fit our population definition. After removing closed, duplicated, or otherwise out-of-range cases, we were left with 1,785 schools, 1,371 from the original IPEDS list, 318 derived from the AACC database, and 96 which were reported to us in the course of data collection.

We then contacted each of these 1,785 schools by telephone during the summer of 1995, asking each if physics was taught on their campus, and, if so, the name of the relevant department or division and chair or administrator. This effort yielded a list of 1,056 campuses offering physics and 729 that did not. (Included in the 1,056 were 33 where physics was offered in two distinct departments.) This number was comparable to the estimate derived from a recent NSF study of two-year college science instructions. At the same time, the 1,056 represents a considerably lower *percentage* of two-year institutions offering physics than reported by the NSF, 59% as against 85%. The discrepancy springs, of course, from the NSF's shorter overall list of campuses, based on IPEDS alone, in which some individual cases represented entire systems, whereas we worked to disaggregate each individual campus.

We followed up with a two-page survey to the chairs of departments or divisions offering physics, requesting a list of all faculty, both full- and part-time, teaching physics classes during the 1995-96 academic year. We also asked for information on each faculty member's teaching load and whether she or he was a recent hire. Finally, there were a dozen questions dealing with the entire unit's physics curriculum and course offerings, the institutional setting, recent growth or shrinkage, and similar issues. Mail returns were received from slightly more than 70% of the departments, and the rest were contacted by telephone for faculty names at the least. In fewer than 1% of the cases were faculty names not obtained from the department.

After additions and subtractions stemming from subsequent data collection and verification, we were left with a list of 2,542 two-year faculty members teaching physics courses during the Spring 1996 term. These teachers were mailed a detailed questionnaire covering their backgrounds, recent experiences, current out-

look, institutional setting, teaching assignment, and future plans. (Further inquiries yielded the names of an additional 150 faculty members who were added to the list after data collection was completed and hence never surveyed, adding to a total of 2,692 faculty for the Spring term.) Three mail waves produced responses from 47% of the original sample, and a fourth mailing of an abbreviated version of the questionnaire, along with telephone follow-up to departments with non-responding teachers, produced 9% more, for an overall response rate of 56%.

A multi-stage appraisal of the project's methodology by a professional evaluator formed a key component for assessing the comprehensiveness of the survey effort and the quality of the data that were gathered. The evaluator entered the project at an early stage, and worked to integrate her efforts into the study design, providing formative as well as summative feedback.

The first stage of evaluation involved a look at the way the target population was identified, the questionnaire instrument developed, and the actual data collection conducted. Interviews were conducted with project staff and members of the target populations, including two-year college physics program heads and faculty members. Examination of sources used to compile the roster of school names suggested that fewer than 1% of all schools were likely to have been overlooked in assembling the original listing. Follow-up calls to verify the identification of schools offering physics also indicated a high level of accuracy. In addition, after the survey was conducted, a group of teacher respondents were selected at random and queried as to their reaction to the experience, including issues that might have affected the clarity or quality of their answers. While their response was generally quite favorable, a number complained about the length of the survey instrument, the inclusion of items focusing on "personal matters" such as salary, and the paucity of questions dealing explicitly with instructional practices in the classroom and laboratory.

The second stage of the external evaluation included a more systematic assessment of population coverage and data quality. Examination of every case where a department head or faculty member reported the possible existence of a division or department teaching physics that wasn't included in the AIP database yielded an estimated coverage shortfall of 1.5% of departments and less than 1% of physics faculty. Adding in possible departments opened after the list was compiled and incorrect initial administrator reports raised the estimated shortfall to around 2% of faculty.

Given the modest response rate, the evaluator also sought to interview a randomly selected group of non-respondents to assess the potential for response bias severe enough to shed doubt on survey findings. While there was an insufficient number of part-time non-respondents

interviewed to reach any conclusions about this group, the evaluator reported that full-time non-respondents closely resembled full-time respondents in most respects, including age, gender, teaching experience, teaching load, holding a second job, and satisfaction with teaching as a career.

However, there were a few significant differences: the non-respondents contacted were more likely to be teaching technical physics courses and less likely to be teaching traditional algebra-based or calculus-based introductory courses. This discovery should temper reliance on the findings that indicate a general scarcity of technical and applied courses — some of that lack may be attributable to response bias rather than an accurate reading of the actual curriculum offered. However, the broader curricular description derived from department heads reinforces the basic picture provided by physics faculty that courses designed specifically for two-year college instruction do not predominate in the physics curriculum.

The second major difference between non-respondents and respondents involved prevalence of membership in AAPT, not altogether surprising given that the survey was undertaken by an organization with links to that professional society. This bias was later extensively explored in the process of analyzing survey results, using name matching of respondents and non-respondents to AAPT membership rolls. The level of bias uncovered by that systematic effort, discussed in detail in **Section IV** of the report, matched almost perfectly the estimates provided by the evaluator, and suggests that some caution is due in interpreting the findings discussed in this report that relate to professional involvement and its major correlates.

APPENDIX C — SURVEY INSTRUMENTS

1. 2-Page Department/Division Chair Survey

2. 10-Page Physics Faculty Survey

AMERICAN INSTITUTE OF PHYSICS
1995 SURVEY OF TWO-YEAR COLLEGE DEPARTMENT/DIVISION CHAIRS

Thank you for participating in this survey of two-year colleges. Please fill out the following information about the faculty in your department or division **who teach physics***, and the physics courses they teach. Please return your completed questionnaire in the enclosed pre-paid envelope to the American Institute of Physics.

THIS FORM WAS COMPLETED BY:

____
name

____
job title

____
campus

PLEASE UPDATE ANY INCORRECT INFORMATION ABOVE.

*** PLEASE NOTE:** In filling out this questionnaire, please include, in addition to regular physics courses, any course in which **at least half** of the content covered is physics, even if it is not explicitly called a physics course.

A. Is your department or division offering any **physics courses** (as defined above) this year?
- [ ] No ⇨ Please complete questions B and C and return the form to us in the enclosed pre-paid envelope. It is important for us to hear from you.
- [ ] Yes ⇨ Please complete questions B and C and the remainder of the questionnaire.

B. Are there any other departments or divisions on **your campus** which offer physics courses?
- [ ] No
- [ ] Yes ⇨ Name of Division ______________________ Name of Chair ______________________

C. Does your campus offer an associate degree in: (a) any subject? [ ] Yes [ ] No
(b) physics or applied physics? [ ] Yes [ ] No

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1. Please list the names the names of all the faculty members who are teaching at least one physics course **this term**. Include both ~~full time and part time faculty who teach these courses. Remember to include yourself if applicable~~. Use an attached sheet if necessary. *Please note*: faculty members are considered "full time" if they are employed full time at your institution, regardless of how many physics courses they teach.

FACULTY NAME	Full time or Part time? (circle one)	Number of **physics courses** (preps) this term	Total number of physics **sections** this term	Teaches courses **other than physics?** [✓]	Hired in the **last three** years? [✓]
a.______	FT PT	____	____	____	____
b.______	FT PT	____	____	____	____
c.______	FT PT	____	____	____	____
d.______	FT PT	____	____	____	____
e.______	FT PT	____	____	____	____
f.______	FT PT	____	____	____	____
g.______	FT PT	____	____	____	____
h.______	FT PT	____	____	____	____

⇩

Total sections this term (sum a - h): ____

---

2. Are there other faculty members scheduled to teach physics **next term** who are not listed above?
- [ ] No
- [ ] Yes ⇨ Please list their names:

(circle one)
______________________ FT PT
______________________ FT PT
______________________ FT PT
______________________ FT PT

BEST COPY AVAILABLE

(over, please >>>)

3. Please provide the following information about all the physics courses your department or division offers **this academic year, even those not offered this term**. Please include courses in which at least half of the content covered is physics, even if they are not called physics courses. (Use an attached sheet if necessary.)

Course number	COURSE NAME	Any physics prerequisites for this course? [✓]	Math required: N – none or minimal, A – algebra, C – calculus	Is this course taught this term? [✓]	How many sections offered this term?	Will this course be offered in another term? [✓]
a.____	________	____	N A C	____	____	____
b.____	________	____	N A C	____	____	____
c.____	________	____	N A C	____	____	____
d.____	________	____	N A C	____	____	____
e.____	________	____	N A C	____	____	____
f.____	________	____	N A C	____	____	____
g.____	________	____	N A C	____	____	____
h.____	________	____	N A C	____	____	____

⇩

Total sections this term (sum a - h): ____ *(NOTE: this total should agree with that in question 1.)*

4. What majors, degree or certificate programs on your campus **require** students to take at least one course in physics? Check here [ ] if none require physics.

*(1)*____________ *(2)*____________ *(3)*____________

5. How many full time faculty members who taught physics: (a) **retired** in the **last three** years? _____
(b) left **prior to retirement** in the **last three** years? _____

PLEASE ANSWER QUESTIONS 6 THROUGH 14 FOR YOUR ENTIRE DEPARTMENT OR DIVISION.

6. Does your department or division offer introductory astronomy courses?
[ ] Yes
[ ] No ➪ Does any other department/division on your campus offer astronomy? [ ] Yes ➪ Please give department name ____________ [ ] No

7. In what other disciplines does your department or division offer courses? (Please check all that apply.)
[ ] Physics only
[ ] Chemistry
[ ] Biological Sciences
[ ] Engineering
[ ] Earth Sciences
[ ] Mathematics
[ ] Computer Science
[ ] Other (Please list) ____________

8. In total, how many **full time** faculty teach in your department/division? _____

9. In total, how many **part time** faculty teach in your department/division? _____

10. How has the **full time equivalent** number of faculty in your department/division changed over the **last three** years?
[ ] increased
[ ] stayed about the same
[ ] decreased

11. How has the proportion of **part time** faculty in your department/division changed over the **last three** years?
[ ] increased
[ ] stayed about the same
[ ] decreased

12. How many clerical and administrative support staff work in your department/division? _____

13. How many lab assistants and other instructional support staff work in your department/division? _____

14. (a) Start and end dates of: (a) **current** term ___/___ to ___/___ (month/year, month/year) (b) **next** term ___/___ to ___/___ (month/year, month/year)

PLEASE NOTE:
In the future, we plan to compile a directory of two-year college departments and divisions which offer physics courses.

If you do *NOT* wish to have your department or division included in such a directory, please check here: [ ]

THANK YOU FOR YOUR PARTICIPATION.

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AMERICAN INSTITUTE OF PHYSICS

1996 SURVEY OF TWO-YEAR COLLEGE PHYSICS FACULTY

Thank you for participating in this survey. (If you are not teaching any physics during the 1995-96 academic year, please check here [ ] and return the form blank.) The questionnaire is organized in sections that deal with different aspects of your work. Section I focuses on your current teaching position and your teaching duties for the term (semester or quarter) in effect as of February 1, 1996.

I. YOUR CURRENT TEACHING POSITION

1. What is your current employment status at this two-year college (please check the appropriate box):
   - [ ] full-time, teaching only
   - [ ] full-time, teaching and administration
   - [ ] part-time

2. Does your institution grant tenure to faculty?
   - [ ] yes (please answer part a)
   - [ ] no (please answer part b)

   2a. If your college grants tenure, are you:
   - [ ] tenured
   - [ ] not tenured, but on tenure-track
   - [ ] not eligible for tenure (please answer part b)

   2b. If your college does NOT grant tenure, or you are NOT ELIGIBLE for tenure, is your position considered:
   - [ ] permanent
   - [ ] temporary
   - [ ] other ____________________

3. Does your institution use the traditional faculty ranking system (assistant, associate, and full professor)?
   - [ ] yes
   - [ ] no

4. What is your job title? (Include rank if applicable) ____________________

5. What is considered a **typical full-time** teaching load at your college? ____ courses per term OR ____ credit hours per term

6. What is **your** teaching load for the current term? ____ courses this term OR ____ credit hours this term

7. On average, approximately how many hours a week are you spending this term for **all** your classes on: (average hrs/wk)
   - a. preparation for lectures and labs .... ____
   - b. committee and administrative work .... ____
   - c. program/curriculum development .... ____
   - d. classroom teaching (lectures or recitation), not including prep time .... ____
   - e. supervising/teaching lab courses, not including prep time .... ____
   - f. advising students/office hours .... ____
   - g. other student contact (please describe) ____________________ ____

   ____

8. Do you have any of the following administrative responsibilities? (Please check all that apply.)
   - [ ] hiring full-time faculty
   - [ ] hiring part-time faculty
   - [ ] choosing texts and curriculum materials for the entire physics program
   - [ ] determining course offerings
   - [ ] other (please describe) ____________________

   ____

9. ***Not counting yourself***, how many other faculty are teaching physics courses in **your** department or division **this** term (this campus only)?
   - a. ____ faculty with full-time appointments
   - b. ____ faculty with part-time appointments

10. Are you aware of any other faculty in **another** department or division on your campus who teach physics this year?
    - [ ] no
    - [ ] yes (please answer part a)

    10a. If yes, how many other faculty? ____

11. Which of the following best describes the office space available to you? (Please choose only one.)
   [ ] I have a private, fully enclosed office.
   [ ] I share office space with another faculty member.
   [ ] I do not have any desk or office space on campus.
   [ ] Other ______________________

12. Which of the following computer resources are available to you? (Please check all that apply.)
   [ ] A computer or terminal in your office on campus
   [ ] A computer at home
   [ ] Access to the Internet
   [ ] Use of e-mail

13. Do you have access to one or more teaching or lab assistants to help you with lab set-up, equipment maintenance, grading, planning, or teaching? (This person need not work solely for you.)
   [ ] yes (please answer part a)
   [ ] no

   13a. If yes, about how many person hours a week, on average, just for your needs? ________

14. For the 1995-96 academic year, how much funding is available to you (either individually or as your share of department funds) for purchasing **physics** curriculum materials, lab equipment and other teaching supplies?

   $ ____________

II. THE COURSES YOU TEACH

15. In the table below, please indicate all subject areas in which you are teaching courses **THIS** term, including the number of different courses and total number of sections. Also indicate the subject areas in which you taught **LAST** term.

Subject	Number of **different courses** (preps) you teach **this term**	Total number of **sections** you teach in this subject **this term**		Did you teach any courses in this subject **last** term?	
		lecture	lab		
a. Physics (see note below)*				yes	no
b. Astronomy				yes	no
c. Chemistry				yes	no
d. Physical science				yes	no
e. Engineering				yes	no
f. Technology (write in titles below)					
1. ______________				yes	no
2. ______________				yes	no
g. Mathematics				yes	no
h. Computer science				yes	no
i. Other science (please specify subjects)					
1. ______________				yes	no
2. ______________				yes	no
j. Other (please specify subjects)					
1. ______________				yes	no
2. ______________				yes	no

* Please Include **all** types of physics courses in your total for line "a". Also include in line "a" **technology** and **physical science** courses in which **at least half** of the content covered is physics. (You will be asked to provide more detailed descriptions of physics courses on the next page.) Physical science courses in which **less than half** of the content covered is physics should be included in line "d". Technology courses in which **less than half** of the content covered is physics should be listed under "technology" in line "f".

16. Please provide the following information for the **PHYSICS** courses you are teaching **THIS term**.

Type of Course	Course number	Total number of sections **you teach** this term: lecture	lab	Total number of students in **your** sections	Total number of women in **your** sections	Is this course part of a multi-term sequence?	Textbooks or materials used (see code list below)		
a. Intro/first year general physics with calculus						yes no			
b. Intro/first year general physics with algebra/trig						yes no			
c. Advanced (2nd year) physics						yes no			
d. Conceptual physics						yes no			
e. Technical/applied physics						yes no			
f. Physical science*						yes no			
g. Technology** (write in titles below)									
1. ________						yes no			
2. ________						yes no			
h. Other physics (write in titles below)									
1. ________						yes no			
2. ________						yes no			
Total physics sections you teach this term: (should agree with line "a" in question 15.)		lecture	lab						

* Please include only those physical science courses in which **at least half** of the content covered is physics.

** Please include only those technology courses in which **at least half** of the content covered is physics.

TEXTBOOK/MATERIALS CODES (for last column of #16 above.)

1. Beiser, *Modern Technical Physics*
2. Giancoli, *Physics for Scientists & Engineers* (calculus-based)
3. Giancoli, *Physics: Principles with Applications* (algebra-based)
4. Halliday et al., *Fundamentals of Physics*
5. Hewitt, *Conceptual Physics*
6. Kirkpatrick & Wheeler, *Physics: a World View*
7. O'Hanion, *Physics, Vols I & II*
8. Serway, *Physics for Scientists & Engineers* (calculus-based)
9. Serway & Faughn, *College Physics* (algebra-based)
10. Tippens, *Applied Physics*
11. Wilson, *College Physics* (algebra-based)
12. Wilson, *Technical College Physics* (technical)
13. Young, *University Physics*
14. Other text 1 ________
15. Other text 2 ________
16. Other text 3 ________
17. Academic software 1 ________
18. Academic software 2 ________
19. Reading packet assembled from multiple sources
20. Your own materials ________

17. During the ***past three years***, would you say each of the following has decreased, stayed about the same, or increased in your department? (Please circle the appropriate number.)

	de-creased	stayed the same	in-creased
a. the variety of physics courses offered	1	2	3
b. the number of sections of physics offered	1	2	3
c. the number of full-time faculty who teach physics	1	2	3
d. the number of part-time faculty who teach physics	1	2	3
e. the number of students enrolled in physics courses	1	2	3

18. Does your department have a program in place to increase enrollments in physics courses?
   [ ] yes (please answer part a)
   [ ] no

   18a. If yes, please rate the program's effectiveness:

1	2	3	4	5
not at all effective				very effective

19. Does your **college** cooperate with local high schools in a **formal** school-to-work transition program for the training of technicians?
   [ ] yes (answer parts a and b)
   [ ] no (skip to question 20)
   [ ] not sure (skip to question 20)

   19a. If yes, give name(s) of program(s)________________________

   ____

   19b. If yes, is your department involved in this program?
   [ ] yes (answer part c)
   [ ] no
   [ ] not sure

   19c. If you answered 'yes' to part b, please indicate the nature of your department's involvement. (Check all that apply)
   [ ] offers courses that are part of the program
   [ ] helps develop the two-year college curriculum for the program
   [ ] helps develop the high school curriculum for the program
   [ ] other (please describe)____________________

   ____

20. Does your physics program have any of the following transfer or articulation agreements?

a. blanket agreements with colleges or universities in your state	yes	no
b. agreements with individual colleges/universities	yes	no
c. physics courses open to students from local high schools	yes	no
d. courses at local high schools which transfer to your program	yes	no

21. Does the physics program receive guidance from an industry-based curriculum advisory committee?
   [ ] yes
   [ ] no
   [ ] not sure

22. Are any of the courses **you teach this term** (including both physics and non-physics) organized in response to the specific needs of local employers?
   [ ] yes (answer part a)
   [ ] no

   22a. If yes, which courses?

	course #	**course name**
1.	______	____________________
2.	______	____________________
3.	______	____________________

III. YOUR PHYSICS STUDENTS

Please respond for students in your physics classes **this term** only. (If you are **not** teaching any physics courses this term, **please skip to section IV.**)

23. Approximately what percent of the students in your **physics classes this term** are:

   Non-US citizens _______%
   US Citizens:
   - African American _______%
   - Asian American _______%
   - American Indian _______%
   - Hispanic American _______%
   - White _______%
   - Other ________________ _______%

   (Total should sum to 100%)

24. Are students required to use any of following equipment in your introductory physics courses? If yes, how adequate is the supply, and how well-prepared are students to use it when they begin your courses?

	required in intro courses?		supply: adequate	supply: inadequate	students' initial preparation: adequate	students' initial preparation: inadequate
a. graphing calculators	yes	no	[ ]	[ ]	[ ]	[ ]
b. computers for student use in labs	yes	no	[ ]	[ ]	[ ]	[ ]
c. computers for student use in the classroom	yes	no	[ ]	[ ]	[ ]	[ ]

25. Does your college operate a science resource or tutorial center?

[ ] yes (please answer part a)

[ ] no

25a. If yes, which of the following services does it provide to students? (Please check all that apply.)

[ ] tutoring by full-time staff

[ ] tutoring by part-time staff

[ ] tutoring by students

[ ] computer tutorial or lab software

[ ] video tapes and other media

[ ] other (please describe)________________

____

26. Which of the following resources are available to the physics students in your department? Of those that are available, please indicate those in which are you involved.

	Available to students?		Are you nvolved?	
a. honors physics courses	yes	no	yes	no
b. chapter of the Society of Physics Students	yes	no	yes	no
c. other science or engineering-related club or society	yes	no	yes	no
d. programs to encourage women in science and engineering	yes	no	yes	no
e. programs to encourage minorities in science and engineering	yes	no	yes	no
f. other ________________ ________________	yes	no	yes	no

27. Does your department or division have any arrangements (including internships and co-ops) to place your students with specific employers during or after their course of study?

[ ] yes (please answer part a)

[ ] no

27a. If yes, please describe the arrangements.

____

____

____

IV. YOUR WORK EXPERIENCE

28. At what point did you first decide to teach at the two-year college level?

[ ] As an undergraduate or earlier

[ ] In graduate school

[ ] During my initial job search

[ ] After starting out in a different career

29. How many years have you taught at THIS college? _____ years

30. IN TOTAL, how many years have you taught at the two-year college level, including this college? _____ years

31. What is your salary for teaching at this college for this academic year? (Please include your **base salary** only. Do **not** include supplemental earnings for teaching overloads, summer school, or other work.)

$________________

31a. For the salary you reported above, what is the salary base?

[ ] 9 or 10 month base

[ ] 11 or 12 month base

32. Do you consider the position you hold at this college to be your primary employment?

[ ] yes

[ ] no

33. Do you currently have another job in addition to teaching at THIS two-year college?

[ ] no (please go to #34 at right | |)

[ ] yes (please fill out **Column I** below, then go to #34 at right | |)

34. Did you hold other types of professional positions before becoming a TYC teacher?

[ ] no (go to #35)

[ ] not applicable, still in graduate school (go to #35)

[ ] yes (please fill out **Columns II & III** below)

	Please fill out Column I below for the **other** job you **currently** have.	Please fill out Column II below for the **first** type of professional position you held.	Please fill out Column III below for the **last** type of work you did before TYC teaching **if it differs from Column II.**
	Column I	**Column II**	**Column III**
a. Type of employer (from list A below)	___	___	___
b. Primary work activity (from list B below)	___	___	___
c. How many years at this position?	___ yrs	___ yrs	___ yrs
d. Full- or part-time?	FT PT	FT PT	FT PT

LIST A Employer type	LIST B Primary work activity
a. another 2-year college	a. teaching
b. high school	b. education administration
c. 4-year college or university	c. research & development
d. private industry	d. engineering
e. military	e. management
f. civilian government	f. other
g. other	

35. Do you have summer employment?

[ ] yes, teaching at this college

[ ] yes, but **not** teaching at this college (answer part a)

[ ] no

35a. If you have summer employment, but not teaching at this college, please indicate your summer employer type and activity:

Summer employer type (list A) ______

Summer work activity (list B) ______

36. Do you plan to teach at a two-year college until you retire?

[ ] definitely (please skip to question 37)

[ ] probably (please skip to question 37)

[ ] probably not (please answer parts a & b)

36a. If you do **not** plan to teach at a two-year college until retirement, please select from list A above the type of employer and from list B above the work activity which describes the work you plan to do.

Employer type (list A) ______

Work activity (list B) ______

36b. If you do **not** plan to teach at a two-year college until retirement, what is the **main** reason you would change? (Please check only one reason.)

[ ] better pay

[ ] more opportunity to conduct research

[ ] opportunity to teach courses at a different level

[ ] increased potential for professional growth and advancement

[ ] I'm tired of teaching; I need a change

[ ] Other (please elaborate)____________________

____

37. Briefly describe why you decided to teach at a two-year college:

____

____

____

____

V. YOUR EDUCATIONAL BACKGROUND

38. Please indicate ALL college degrees you have earned, the year you earned each, and the academic department and field of specialization in which you earned each degree. If you had a full double major, list as two separate degrees earned in the same year.

> NOTE: If you are **currently pursuing a graduate degree**, please check here [ ] and fill out the information for the appropriate degree level, using the year you expect to earn the degree.

Degree	**Year Earned**	**Department Name**	**Field of Specialization**
Bachelor's	19____	____________________	____________________
2nd Bachelor's	19____	____________________	____________________
Master's	19____	____________________	____________________
2nd Master's	19____	____________________	____________________
PhD	19____	____________________	____________________
EdD	19____	____________________	____________________
Other __________	19____	____________________	____________________

39. If you do not have a degree in physics, please indicate, to the best of your recollection, the number of undergraduate and graduate courses and credit hours you have taken in physics.

a. Undergraduate		b. Graduate	
courses	credits	courses	credits
_____	_____	_____	_____
(if quarter system, check here [ ])		(if quarter system, check here [ ])	

VI. PROFESSIONAL ACTIVITIES

40. How often do you interact professionally with colleagues in the following groups?	rarely or never	about once a semester	several times a semester	weekly or more often
a. physics faculty at **your** two-year college	1	2	3	4
b. other science-engineering-technology faculty at **your** two-year college	1	2	3	4
c. physics faculty at **other** two-year colleges	1	2	3	4
d. other science-engineering-technology faculty at **other** two-year colleges	1	2	3	4
e. physics faculty at four-year colleges or universities	1	2	3	4
f. other science-engineering-technology faculty at four-year colleges or universities	1	2	3	4
g. high school physics teachers	1	2	3	4
h. other high school science teachers	1	2	3	4

41. Please indicate **approximately** how many times you engaged in each of the following activities during the LAST TWO YEARS (January 1994 to December 1995).

How many times? (if none, write '0')

a. attended a professional meeting ______
b. gave a talk or presided over a session at a professional meeting ______
c. attended a minicourse or workshop for physics educators ______
d. conducted a minicourse or workshop for physics educators ______
e. took an upper division or graduate level physics course ______
f. had a scientific research article published ______
g. had an educational research article published ______
h. had a nonresearch article published ______
i. reviewed or evaluated a grant proposal or journal article ______
j. wrote a textbook or a book chapter ______
k. wrote a grant proposal ______
l. received a grant ______
m. other ______________________________ ______

42. During the **last twelve months**, have you received institutional support in the form of funding or release time for:	no--support unavailable	no--it was available, but I didn't use it	yes--some support but not enough	yes--enough support for my needs
a. travel to conferences and workshops	1	2	3	4
b. registration for conferences & workshops	1	2	3	4
c. curriculum/program development	1	2	3	4

43. Please indicate how familiar you are with each of the following physics teaching resources:		●● heard of it, but don't use it because ●●				
	never heard of it	don't like it	not suitable	not available	use it sometimes	use it regularly
a. ALPS	1	2	3	4	5	6
b. CBL	1	2	3	4	5	6
c. CE/OCS	1	2	3	4	5	6
d. CUPLE	1	2	3	4	5	6
e. IUPP	1	2	3	4	5	6
f. MBL	1	2	3	4	5	6
g. Force Concept Inventory	1	2	3	4	5	6
h. Mechanics Baseline Test	1	2	3	4	5	6
i. Ranking Tasks	1	2	3	4	5	6

44. If there are other teaching resources, not listed above, that you use regularly in your physics classes, please list and briefly describe them below:

____

____

____

45. Are you a member of any of the following professional organizations? (If you are not a member of any professional organizations, please check here [ ] and go on to question 46.)

	Membership Level Nat'l	State/ Reg'l	Local
a. Amer. Assn. of Physics Teachers (AAPT)	[ ]	[ ]	[ ]
b. Amer. Physical Soc. (APS)	[ ]	[ ]	[ ]
c. Amer. Chemical Soc. (ACS)	[ ]	[ ]	[ ]
d. Nat'l Science Teachers Assn. (NSTA)	[ ]	[ ]	[ ]
e. Amer. Mathematical Assn. of TYCs (AMATYC)	[ ]	[ ]	[ ]
f. Nat'l Council of Teachers of Mathematics (NCTM)	[ ]	[ ]	[ ]
g. Amer. Soc. of Engineering Education (ASEE)	[ ]	[ ]	[ ]
h. Other ________	[ ]	[ ]	[ ]

46. What methods are used regularly to evaluate your performance as a two-year college teacher? (Please check all that apply.)

[ ] Not applicable, my performance is not evaluated on a regular basis.

[ ] observation of classes by other faculty in your department or division

[ ] observation of classes by my department chair/division head

[ ] observation of classes by another administrator

[ ] written evaluations by students

[ ] assessment of my service on department-level committees

[ ] assessment of my service on college-wide committees

[ ] appraisal of my research in education

[ ] appraisal of my research in physics or other scientific field

[ ] other ________

VII. YOUR VIEWS ABOUT YOUR WORK

47. Please indicate the extent to which you agree or disagree with each of the following statements about two-year college teaching:

	strongly disagree	somewhat disagree	neutral	somewhat agree	strongly agree
a. I have control over the most important aspects of my job.	1	2	3	4	5
b. I would rather be teaching at a four year college or university.	1	2	3	4	5
c. I have ample opportunities to share ideas with other faculty.	1	2	3	4	5
d. My job is quite secure for the foreseeable future.	1	2	3	4	5
e. Part-time faculty are undervalued in my department/division.	1	2	3	4	5
f. I prefer physics teaching over physics research.	1	2	3	4	5
g. I prefer teaching physics to teaching other subjects.	1	2	3	4	5
h. Only people with a graduate degree in physics or the equivalent graduate hours in physics should be allowed to teach physics at the two-year college level.	1	2	3	4	5
i. Two-year college physics as it is currently taught is too closely aligned with undergraduate courses at four-year colleges and universities.	1	2	3	4	5
j. I spend too much time teaching technical skills in my physics classes.	1	2	3	4	5
k. Given my level of education and experience, I consider myself to be underemployed.	1	2	3	4	5
l. For the most part, two-year college physics faculty are well respected by the rest of the academic physics community.	1	2	3	4	5
m. If I had it to do over again, I would still choose to go into two-year college teaching.	1	2	3	4	5

48. To what extent is each of the following a problem for you?

	serious problem	minor problem	not a problem
a. Lack of support from my department or division administration	1	2	3
b. Lack of support from other faculty in my department or division	1	2	3
c. Lack of resources for doing research	1	2	3
d. Pressure to conduct and publish research	1	2	3
e. Too many non-teaching responsibilities	1	2	3
f. Inadequate space for lab, or facilities outmoded	1	2	3
g. Insufficient funds for equipment and supplies	1	2	3
h. The amount of time required to prepare labs	1	2	3
i. Teaching load too heavy	1	2	3
j. Classes too large	1	2	3
k. Students' weak math backgrounds	1	2	3
l. Students' lack of interest in physics	1	2	3
m. Other (please describe)________________	1	2	3

49. What aspects of your work as a two-year college teacher do you find most **satisfying**?

____

____

____

50. What aspects of your work as a two-year college teacher do you find most **dissatisfying**?

____

____

____

VIII. PERSONAL DATA

51. Gender: [ ] female [ ] male

52. Year of birth: 19_____

53. What is your citizenship status?
   [ ] U.S. citizen
   [ ] noncitizen, temporary visa (please answer part a)
   [ ] noncitizen, permanent visa (please answer part a)

53a. citizen of: ______________________
country

54. To which racial or ethnic group do you belong?
   [ ] American Indian or Alaskan Native
   [ ] Asian or Pacific Islander
   [ ] Black, nonhispanic
   [ ] Hispanic
   [ ] White, nonhispanic
   [ ] Other (please specify) ______________

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